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*The Commonwealth of Massachusetts*

ANNUAL REPORT

OF THE

METROPOLITAN DISTRICT  
WATER SUPPLY COMMISSION

FOR THE

YEAR ENDING NOVEMBER 30, 1933







# REPORT OF THE METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

*To the Honorable the Senate and House of Representatives of the Commonwealth  
of Massachusetts in General Court assembled.*

The Metropolitan District Water Supply Commission, established under the provisions of Chapter 375 of the Acts of 1926, respectfully presents for the year ending November 30, 1933, its

## EIGHTH ANNUAL REPORT

### I. ORGANIZATION AND ADMINISTRATION

Davis B. Keniston continued during the year as Chariman of the Commission, and Charles M. Davenport and Thomas D. Lavelle, both of Boston, as Associate Commissioners. R. Nelson Molt continued as Secretary.

The clerical force of the Commission's office at Boston remained substantially the same throughout the year. Three special agents under the direction of the Commission continued to care for the property acquired by the Commission in the Swift River and Ware River areas. Real estate purchasing agents and conveyancers and other experts were employed as needed. The engineering and clerical force of the engineering department averaged 148 employees during the year. The maximum number employed at any one time by contractors on the various construction projects during the year was 886 persons.

The Commission continued, through duly appointed agents, the direction of the town government of the Town of Prescott, as provided by Chapter 340 of the Acts of 1928. A financial statement for the town is included in the Commission's report to the Commissioner of Corporations and Taxation.

### II. ENGINEERING DEPARTMENT

Frank E. Winsor continued as Chief Engineer, Karl R. Kennison as Designing Engineer, and Walton H. Sears as Mechanical Engineer.

The field divisions were continued in charge of three division engineers as follows: Wachusett-Coldbrook Tunnel Division, William W. Peabody; Coldbrook-Swift Tunnel Division, Richard R. Bradbury; Quabbin Reservoir Division, N. LeRoy Hammond.

The Commission retained the services of X. H. Goodnough, Inc., and of J. Waldo Smith, formerly Chief Engineer of the New York Board of Water Supply, as consulting engineers until the death of the latter on October 14.

By the death of Mr. Smith the Commission lost one of its ablest counsellors. Born and reared in Massachusetts, after graduating from the Massachusetts Institute of Technology and following early experience in this state, he became chief engineer of large water supplies in Eastern New Jersey. In the year 1903 he became chief engineer on the Croton water supply of the city of New York, and two years later chief engineer on the Catskill water works for that city. For thirty years he guided the development of New York's water supply as chief engineer and consulting engineer, and was frequently called upon for advice elsewhere. He served as consultant in early investigations for the new water supply of the Metropolitan District, and had served the Commission since its creation in 1926.

Charles T. Main, of Charles T. Main, Inc., of Boston, was employed from time to time as a general consultant on mill and water power damages and also on the design of the dam and dike of Quabbin Reservoir. Dr. Charles P. Berkey of Columbia University continued as consulting geologist. Other consultants were employed from time to time as needed.

### III. OFFICES

The office of the Commission and of the Chief Engineer continued on the ninth floor of the Metropolitan District Commission Building at 20 Somerset Street, Boston. The division offices for the Wachusett-Coldbrook Tunnel section and of

the Coldbrook-Swift Tunnel section of the Quabbin Aqueduct and of the Quabbin Reservoir area continued at Holden, Hardwick and Enfield, respectively. The laboratories for water analysis and soil testing were continued at Enfield.

#### IV. REAL ESTATE AND WATER RIGHTS

The Commission, for reservoir purposes, has acquired (or has under option) a total of 56,038 acres of land in the Swift River watershed, and for sanitary protection and construction purposes in the Ware River watershed a total of 5,547 acres.

The Commission acquired by eminent domain 173.51 acres in fee, and easements in 6.86 acres of land in the towns of Belchertown, Pelham, Shutesbury, New Salem and Orange for road construction, and easements in 22.94 acres of land in the towns of Rutland and Holden for the construction of a trunk sewer for the disposal of sewage from the Ware, Quinapoxet and Wachusett watersheds.

Under the provisions of Section 5 Chapter 321 of 1927, the Supreme Court appointed, on April 5, 1933, as a Board of Referees, Thomas R. Hickey, Esq., of Easthampton, Nathan P. Avery, Esq., of Holyoke and Robert W. King, Esq., of Springfield. Mr. Hickey died June 14 and James M. Healy, Esq., of Springfield, was appointed to fill the vacancy.

The Commission has, during the year, concluded settlements with two owners of water privileges on the Ware River for the diversion of the waters of the Ware River and with four owners of water privileges on the Chicopee River for all claims for present and future damages caused by the diversion of the Ware and Swift rivers.

#### V. SOUTHERN SUDBURY SUPPLY

All work upon the Southern Sudbury Supply having been completed, the works and all other property incidental thereto were, on April 18, turned over to the Metropolitan District Commission for maintenance and operation.

#### VI. WARE RIVER SUPPLY

The Commission purchased some additional properties for protection of the watershed of the Ware River including the property in Rutland under the control of the Department of Correction, comprising the Massachusetts Prison Camp and Hospital, and in conjunction with the Department of Public Health has continued its studies of possible sources of pollution from that watershed and the best methods for their elimination.

Under the provisions of Chapter 262 of the Acts of 1932, the Commission concluded an agreement with the City of Worcester for the disposal of sewage to be diverted from the watersheds of the Ware and Quinapoxet rivers and the watershed of Wachusett Reservoir into the sewerage system of the city. The Commission subsequently authorized the construction of a trunk sewer from the Rutland State Sanatorium and the U. S. Veterans' Hospital in the neighborhood of Rutland Center through Rutland and through or near the villages of Eagleville and Holden Center in the town of Holden to a point at the boundary line between Holden and Worcester to connect with a sewer line of the city of Worcester to be built and maintained by the city under this agreement with the Commission from that point to its existing system. Contract No. 39 was awarded on July 11 to James J. Coughlan & Sons, Inc., of Boston, for constructing the sewer in Rutland and Holden. The two temporary chlorinating plants installed at points in the upper watershed of the Ware River were maintained in readiness for operation.

No water was diverted during the year from the Ware River.

#### VII. SWIFT RIVER SUPPLY

Real estate and topographic surveys were continued during the year.

The Wenzel & Hensch Construction Company continued under Contract No. 20 for the construction of the Coldbrook-Swift section of the Quabbin Aqueduct. The rock excavation has been completed and about 45% of the 10.4 miles of the tunnel included in this contract has been lined with concrete.

Contract No. 30 which was awarded in July, 1931, to the Northern States Contracting Company, for constructing the river diversion tunnel at the site of the main dam of Quabbin Reservoir, was completed on July 1.



Contract No. 36 was awarded on December 28, 1932, to the West Construction Company, the contractor who had successfully completed 13 miles of the Wachusett-Coldbrook section of Quabbin Aqueduct, for constructing a core wall to sound rock at the site of the dike of Quabbin Reservoir in the towns of Enfield and Ware. Work has been in progress under this contract, the open trench across the Valley 40 feet below the level of Beaver Brook being completed and the caisson or core wall substantially completed. There are in all 31 caissons across the Valley and 17 on the easterly end of the dike have been sunk to bed rock and sealed. The remaining 14 caissons on the westerly end have been placed and are partially down to bed rock.

The Commission arranged with the New England Power Company and the Central Massachusetts Electric Company to remove and relocate the power transmission lines extending across Quabbin Reservoir site. These relocations were economical at this time since owing to decreased demands for power it was possible to discontinue these lines temporarily and use the towers and other equipment upon the new locations. The relocations to the south and to the west of the reservoir are substantially completed.

Three contracts were awarded for the construction of a highway west of the reservoir site about twenty-one miles long from Belchertown to a point just beyond the road between North Dana and Orange. The road starts at Belchertown-Amherst highway about one-half mile north of Belchertown Center and passes through Pelham Center, the Village of Cooleyville and just westerly of the Village of New Salem to a point just beyond the Orange-North Dana Road.

The location for this new road was approved by the County Commissioners of Franklin and Hampshire Counties and by the Department of Public Works and is being built in cooperation with the Department of Public Works and when completed will be taken over and operated by that Department as a state highway.

Contract No. 41 for the southerly portion of this road, about 9.1 miles in length, and extending from the road leading from Belchertown Center to Amherst through Pelham Center, was awarded to Carlo Bianchi and Company, Inc., of Framingham, Mass., on July 19. Contract No. 43 for the central portion of 7.6 miles extending from about  $\frac{1}{2}$  mile beyond Pelham Center through the village of Cooleyville and ending just north of New Salem Center was awarded to V. Barletta Company of Roslindale, Mass., on August 22. Contract No. 44 for the last and northerly portion of the highway, about 4.1 miles in length, extending from a point north of New Salem Center to and across the North Dana-Orange State highway, was awarded on November 14 to John Iafolla Construction Company of Dedham, Mass.

#### VIII. CEMETERIES

The Commission has continued the assignment of lots in the new Quabbin Park Cemetery and 659 bodies were removed from the Quabbin Reservoir area during the year of which 589 have been interred in Quabbin Park Cemetery. There have also been a total of 30 original burials made in the Cemetery. To date a total of 1,419 bodies have been removed from the Quabbin Reservoir area.

#### IX. FINANCIAL

The Commission appends hereto a statement of its expenditures and disbursements for the fiscal year, and from the date of its appointment.

#### X. OTHER REPORTS

The report of the Chief Engineer is herewith presented.

Respectfully submitted,

DAVIS B. KENISTON, *Chairman.*

CHARLES M. DAVENPORT, *Associate Commissioner.*

THOMAS D. LAVELLE, *Associate Commissioner.*

20 SOMERSET STREET, BOSTON, MASS.

January 15, 1934.

## REPORT OF THE CHIEF ENGINEER

*To the Metropolitan District Water Supply Commission.*

GENTLEMEN: — The following is a report of the engineering department for the year ending November 30, 1933.

### ORGANIZATION

It has been necessary to increase the engineering organization about 20% during the year to handle the new and additional construction.

Karl R. Kennison, Designing Engineer, continued in charge of all studies in connection with the general plan of the work and the design of structures, preparation of contract specifications, contract and working drawings. He also continued as principal assistant to the Chief Engineer.

Charles L. Coburn and Stanley M. Dore, Assistant Designing Engineers, continued their general supervision of the detailed work of the office; and Walton H. Sears, Mechanical Engineer, continued in charge of the collection of data in connection with mill and water power damages. They have assisted in the preparation of contract specifications.

Three division engineers continued in charge of field divisions as follows: William W. Peabody, Wachusett-Coldbrook Tunnel Division; Richard R. Bradbury, Coldbrook-Swift Tunnel Division; N. LeRoy Hammond, Quabbin Reservoir Division.

X. Henry Goodnough, Inc., and J. Waldo Smith, until his death October 14, continued as consulting engineers. Charles T. Main, consulting engineer of Boston, Dr. Charles P. Berkey, geologist of Columbia University, Arthur A. Shureliff, landscape architect of Boston, and other experts were employed from time to time.

The assignment of employees under the direction of the Chief Engineer at the end of the year and of the preceding year was as follows:

	Nov. 30, 1932	Nov. 30, 1933
Headquarters Office, Designing Division . . . . .	36	38
Holden Office, Wachusett-Coldbrook Tunnel Division . . . . .	22	26
Hardwick Office, Coldbrook-Swift Tunnel Division . . . . .	30	40
Enfield Office, Quabbin Reservoir Division . . . . .	47	61
Total Engineering Force . . . . .	135	165

The maximum force during the year was 165, during the six weeks ending November 25. The minimum force was 134, during the three weeks ending January 28. The average force for the year was 148.

### OFFICES

The office of the Chief Engineer and Designing Division was continued in the Metropolitan District Commission Building at 20 Somerset Street, Boston. The field office of the Wachusett-Coldbrook Tunnel Division was continued at Washburn Hall, Holden Center. The field office of the Coldbrook-Swift Tunnel Division was continued in the brick building formerly used as a school at Hardwick Center. The field office of the Quabbin Reservoir Division was continued in the property of the Commonwealth formerly known as the Frances W. Chandler house on Quabbin Road, and the laboratories for water analysis and for soil testing were continued in the property of the Commonwealth formerly known as the Barlow house, in Enfield.

### HEADQUARTERS OFFICE

#### *Summary of the Year's Work*

*Real Estate.* — Reports and recommendations with respect to the purchase of real estate in the Quabbin Reservoir area were submitted to the Commission during the year covering 4,370 acres, making a total reported on to date of 71,010 acres.

#### PROGRESS OF REAL ESTATE NEGOTIATIONS FOR QUABBIN RESERVOIR

	Total Area Negotiated Including Owners' Offers to Sell to Commonwealth (Acres)	Area not Required (Acres)	Title Vested in Common- wealth (Acres)
Total for Year ending Nov. 30, 1933 . . . . .	4,370	403	5,632*
Total to Nov. 30, 1932 . . . . .	66,640	6,792	48,675
Total to Nov. 30, 1933 . . . . .	71,010	7,195	54,307

Options outstanding Nov. 30, 1933, include 1,731 acres.

\* Includes some offered in previous years.



Reports and recommendations were also made with respect to the purchase of real estate for sanitary protection in the Ware River watershed above the intake works at Coldbrook.

PROGRESS OF REAL ESTATE PURCHASES FOR WARE RIVER WATERSHED PROTECTION

	Title Vested in Commonwealth
	(Acres)
Total for year ending Nov. 30, 1933 . . . . .	1,192
Total to Nov. 30, 1932 . . . . .	4,067
Total to Nov. 30, 1933 . . . . .	5,259

Options outstanding Nov. 30, 1933, include 288 acres.

Real estate taking plans were prepared and filed during the year as shown in the appended table.

*Contracts and Specifications.* — Contract 36, for constructing a core wall to sound rock at the site of the dike, so-called, of Quabbin Reservoir in the towns of Enfield and Ware, was executed December 28, 1932.

Plans and specifications were prepared for Contract 39, for constructing a trunk sewer in the towns of Rutland and Holden, for the purpose of maintaining and protecting the purity of the water supplied from the Wachusett, Quinapoxet and Ware river areas as authorized by Chapter 262 of the Acts of 1932. The contract was executed July 11.

Plans and specifications were prepared for Contract 40, for the removal, and relocation outside the flow line of Quabbin Reservoir, of the transmission and telephone lines and substation of the New England Power Company and the Central Massachusetts Electric Company in the towns of Belchertown, Enfield and Ware, and for the alteration of transmission line towers at points where the reservoir will be spanned by the lines of these companies in the town of New Salem. The contract was executed June 20.

Plans and specifications were prepared for Contract 41, for constructing, in substitution for highways in the Quabbin Reservoir area, a portion of the Belchertown-Pelham highway in the towns of Belchertown and Pelham. The contract was executed July 20.

Contract 42 was prepared, being an agreement with the city of Worcester as to compensation for the construction by the City of a connecting link between the Rutland-Holden sewer, being constructed under Contract 39 and the city's trunk sewerage system, and for the right to use this system and the city's treatment plant. The contract was executed May 1.

Plans and specifications were prepared for Contract 43, for constructing an extension of the Belchertown-Pelham highway to New Salem Center in the towns of Shutesbury and New Salem. The contract was executed August 25.

Plans and specifications were prepared for Contract 44, for constructing an extension of the Belchertown-Pelham highway north of New Salem Center in the towns of New Salem and Orange. The contract was executed November 15.

Working drawings for Contracts 20, 30, 36 and 39 were prepared and issued.

Work was in progress on the preparation of plans and specifications for constructing a core wall to sound rock at the site of the main dam of Quabbin Reservoir in the towns of Enfield, Belchertown and Ware similar to that being constructed under Contract 36 at the site of the dike.

*Inspection and Tests.* — E. L. Conwell and Company continued the testing of cement. The Worcester Polytechnic Laboratory continued the testing of concrete cylinders and steel reinforcement bars. William R. Conard of Burlington, N. J., inspected cast-iron pipe furnished for the Rutland-Holden sewer under Contract 39.

The inspection of weir castings purchased by the Commission for installation in the sewage measuring stations under Contract 39 and of special castings for stop log grooves for Contract 20 was made by the engineering force. These measuring weirs were rated by tests made in the Hydraulic Laboratory of the Massachusetts Institute of Technology in Cambridge. The engineering force cooperated with the laboratory personnel in making these tests.

*Hydrographic Data.* — The gaging station on the Ware River at Coldbrook was continued in cooperation with the United States Geological Survey.

The gaging station on the Chicopee River at the United Electric Light Company plant at Bircham Bend was continued in cooperation with that company and the

United States Geological Survey, and further discharge measurements were made from time to time to define the rating curve more exactly.

The gaging station on the Chicopee River at the Red Bridge plant of the Ludlow Manufacturing Associates was continued in cooperation with that company and further discharge measurements were made from time to time to define the rating curve more exactly.

The gaging station on the Swift River at Bondsville was continued in cooperation with the Otis Company.

Cooperation with the United States Geological Survey in the operation and maintenance of the gaging station on the Connecticut River at Thompsonville, Connecticut, was continued.

In connection with the examination of the waters of the Ware, Swift and Chicopee rivers, observations of flow were continued from time to time and additional temporary gaging stations established as required and data for the use of consultants and experts were prepared.

#### *Southern Sudbury Emergency Supply*

Record plans of the Southern Sudbury Emergency Supply were completed, and on April 18 the works and all property incidental thereto were turned over by the Commission to the Metropolitan District Commission. These works consist of (1) a 24-inch gravity flow pipe line from Ashland Reservoir of the District to the gate house at Framingham Reservoir No. 2, (2) a 20-inch gravity flow pipe line from Whitehall Reservoir of the District to a point on City Brook where this brook is diverted by a small diversion dam, reservoir and open channel into Hopkinton Reservoir of the District and (3) a 30-inch gravity flow pipe line from Hopkinton Reservoir across the Sudbury River near Cordaville and into the main Sudbury Reservoir; also a pumping station and a branch line from an intake on the Sudbury River at Cordaville.

#### *Ware River Diversion*

There was no diversion of Ware River water into Wachusett Reservoir. In the period June 15 to October 15, inclusive, in conformity with the requirements of the War Department, no water was diverted. At other times, the daily flow in the river was frequently sufficient to permit diversion, but no diversion was made because of the present inadequacy of storage capacity in the reservoir of the District.

On January 24 the east tunnel heading from Shaft 9 holed through into the west end of the Wachusett-Coldbrook Tunnel, and the gates in the steel bulkhead about 2,200 feet west of Shaft 8 were closed to prevent leakage past the bulkhead from the operations under Contract 20 and to allow diversions to be made from the Ware River into Wachusett Reservoir without danger of flooding west of the bulkhead. On November 17 an inspection was made of about 7 miles of the Wachusett-Coldbrook Tunnel extending from Shaft 8 easterly to a point between Shafts 4 and 5. On these occasions the intake shaft, the steel bulkhead and the tunnel were found to be in excellent condition.

#### *Design of Structures*

*Shaft 9.* — Designs were continued for an emergency spillway and vent and a head house at the top of Shaft 9.

*Shaft 12.* — Swift River Intake. — Studies were continued of the high level intake and requirements of a head house and a service building. Studies were made of grading at the intake and of a relocation of the existing highway to an elevation about 5 feet above the reservoir flow line opposite the shaft so that the extension of the shaft as a foundation for the head house and filling around the shaft to subgrade can be completed under Contract 20 without further highway changes. Designs were made of stop shutters for unwatering the tunnel under full reservoir head.

*Tunnel Vent.* — Designs were made for a vent hole between Shafts 11 and 12 about 5,700 feet east of Shaft 12 extending from the roof of the tunnel 150 feet to the surface of the ground to vent air that, except for such a vent, could accumulate in the tunnel east of the intake. If air were allowed to accumulate at this point, it might under certain conditions of future operation be vented suddenly under



high pressure and damage the head house at Shaft 12. This vent consists of a 6-inch copper tube grouted in an 8-inch drill hole. At the surface this tube is designed to be enclosed in a concrete block and capped with a cast-iron vent head.

*Caisson Core Wall at Main Dam.* — Designs were made for a concrete core wall from the original surface to sound rock in the bottom of the valley at the site of the main dam to be constructed by sinking from the bottom of an open-cut trench a row of caissons, each 9 feet thick and 45 feet long. These caissons are designed to be sealed to the ledge and to each other in the same manner as is being successfully done under Contract 36 at the site of the dike. The design calls for thirty-eight caissons including the experimental caisson sunk under Contract 32, or seven more than at the dike, where thirty-one have been sunk. Studies were made of the economical depth of open-cut trench to be first excavated before starting the sinking of caissons and the bottom of the trench in the deepest portion of the valley was fixed at about 35 feet below the river level, the remaining distance to ledge being about 90 feet. Each caisson was designed with three 4-foot wells the same as at the dike, the two end wells being for handling muck and the central well for handling men.

*Pumping Ground Water.* — Studies were continued of the permeability of foundation materials at both the main dam and dike sites. Excellent data are available as a result of the continued pumping from the caissons being sunk under Contract 36 and the renewal, on August 15, of pumping from the experimental caisson at the main dam site.

At the dike site pumping was continued throughout the year. On December 1, 1932, pumping was at the rate of 1,237 gallons per minute and the ground water level at the caisson pump sump had been lowered about 60 feet below the original brook level. On January 21, pumping was taken over by the contractor and after completing the installation of additional pumping capacity the rate averaged about 3,200 gallons per minute. On November 30, the ground water level had been lowered about 96 feet. Our studies have indicated that the glacial material in the rock valley is coarser at the lower elevations near the ledge. The average permeability of materials below the ground water surface at the commencement of pumping operations was about 16 million gallons per acre per day under unit slope at 50° F, and at the end of the year about 28.

At the experimental caisson at the dam site, pumping was renewed August 15, following the installation of additional pumps and averaged 2,200 gallons per minute at the end of the year. The ground water level at the caisson pump sump was held practically constant 15 feet below the water level in the river. Preliminary studies indicated that the average permeability of the glacial materials in the main Swift river valley in the vicinity of the main dam is about 35 million gallons per acre per day under unit slope at 50° F and probably the same at all depths below the original surface. Our studies indicated that a large portion of the water pumped was drawn from the old river bed between the upstream and downstream cut-off dams at the entrance and exit of the river diversion conduit completed under Contract 30 and that in spite of the fact that the experimental caisson was not sunk in the deepest part of the rock valley, a considerable additional lowering of the ground water level would result if the old river bed were dried up. Accordingly, designs were made for an extension of the discharge pipe line in the caisson a distance of about 1,000 feet to a point above the upstream cofferdam. This design includes a provision for future weir boxes at the entrance to this steel pipe, the entire layout being designed to fit the requirements of a contractor constructing a complete caisson core wall at the main dam site.

*Main Dam Spillway.* — Studies were made to determine the best location for the main spillway of Quabbin Reservoir. Borings indicate good locations at either end of the dam. At the east end a channel from the spillway can be excavated in solid ledge to a point much closer to the river than in the case of the westerly site. If the easterly site should be adopted for the main spillway, an additional emergency spillway may easily be provided at the westerly site.

*Clearing Reservoir.* — Studies were made of methods of clearing the Quabbin Reservoir site and of the extent of shallow flowage at the margins.

*Main Dam and Dike.* — Studies were continued of designs for the main dam and dike. Explorations were continued under the direction of the headquarters office



by borings and borrow pits to locate suitable material for the construction of embankments. Designs were made for a sluicing bin in which to conduct large scale experiments in the washing of materials available for dam construction. This sluicing bin was constructed in Enfield in the yard of the old Tebo mill and the engineering force supervised the washing tests. The bin was designed with a width of 15 feet between wooden sidewalls about 4 feet high and with a concrete bottom, sloped one to fifty into a depression at one end for the collection of fines during washing with an overflow to a sump from which the circulating water is pumped to the hose nozzles.

*Rutland- Holden Sewer.* — Designs were made for a new open-nozzle type of measuring weir for use on the small sewage pipe lines of the Rutland- Holden sewer. This weir is referred to as an open nozzle because it bears the same relation to a nozzle that an open-venturi does to a venturi meter. Castings made from these designs were tested and rated at the laboratory of the Massachusetts Institute of Technology. One of these nozzles will be installed to measure the discharge from the Rutland State Sanatorium into the upper end of the 10-inch sewer line, another to measure the discharge from the U. S. Veterans' Hospital into the upper end of a 10-inch branch line and another, at the Holden- Worcester line, to measure the discharge from the 16-inch outlet into the trunk sewerage system of the city of Worcester.

*Photographic Records.* — The taking of moving pictures from time to time to illustrate the progress of construction was continued.

*Highway Relocation.* — Studies were continued of highway relocation which will be required because of the construction of Quabbin Reservoir.

*Transmission Line Relocation.* — Studies were made of the relocation of the 66,000-volt transmission line of the New England Power Company between Leverett and Ware which will be required on account of the construction of Quabbin Reservoir. This transmission line crossed the Swift River and its west branch west of Enfield Center and crossed Beaver Brook just north of the dike site. A 22,000-volt circuit followed the same right of way from the substation at Ware to one at Enfield serving Enfield and Belchertown and a telephone line extended the entire length of the 66,000-volt line. These lines and the substation in Enfield were also required to be relocated. The total length of original line affected was about 35,050 feet and the length of relocation 44,780 feet. Studies were also made for increasing the height of towers and other required alterations on the 110,000-volt line of the New England Power Company between Davis Bridge, Vermont, and Millbury at points where this line crosses the north end of the Quabbin Reservoir site.

*Railroad Valuation.* — Valuation studies of that portion of the Athol Branch of the Boston and Albany Railroad which will be affected by the construction of the Quabbin Reservoir were continued.

#### WACHUSETT-COLDBROOK TUNNEL DIVISION — HOLDEN OFFICE

The Wachusett-Coldbrook Tunnel Division continued in charge of all work in connection with improvements on the Ware River watershed, of the location and construction of the Rutland- Holden sewer, of the maintenance and operation of the Ware River intake works and the Wachusett outlet works, of a portion of the surveys for highway relocation in the Quabbin Reservoir area, and of field studies of materials and methods of construction of the main dam and dike.

#### Office Work

Studies were continued of the feasibility of various methods of diverting from the Ware and Wachusett watersheds the sewage from institutions in Holden and Rutland. Topographic and real estate plans were prepared and studies made for the Rutland- Holden sewer. Monthly estimates and working drawings were prepared for Contract 39. Real estate plans were prepared of miscellaneous property in the Ware River watershed, final tracings being made of about 600 acres. Daily rainfall and temperature records were continued at the White Valley meteorological station and daily rainfall records at West Rutland and continuous records of the flow of the Ware River at the intake building were kept. The division continued its cooperation with the Enfield office in the studies and preparation of plans for the relocation of highways which will be made necessary by the construction of Quabbin

Reservoir. For contract use and also for submission to the State Department of Public Works and the County Commissioners of Franklin County, plans were prepared for a section of the extension of the relocated Belchertown-Pelham highway between Cooleyville and New Salem Center. The construction of this new highway west of Quabbin Reservoir is under the supervision of the Enfield office and is hereinafter described. Studies were continued of materials, comparative costs and methods of construction of the proposed main dam and dike.

### *Field Work*

Topographic surveys were continued in connection with the studies of various methods of the disposal of sewage and other wastes from institutions in Holden and Rutland. The topographic surveys made in connection with these studies and the preparation of sewer contract plans covered about 250 acres. Rod soundings and test pits were continued to investigate the material along the line of the proposed Rutland-Holden sewer and in the vicinity of the proposed highway relocation west of Quabbin Reservoir. Lines and grades were given for construction on Contract 39. Photographs of the construction work were made by the Enfield office. Topographic surveys covering about 60 acres were made in connection with the location of new highways in the Quabbin Reservoir area and the preparation of highway contract plans. Real estate surveys were made covering about 284 acres of various properties in the Ware River watershed and about 6 acres along the line of the Wachusett-Coldbrook Tunnel. Additional stone bounds were set during the year. A triangulation system was established in the Ware River drainage area and tied to that previously established by the Hardwick office.

The State Department of Public Health continued its cooperation with this division in the analysis of samples of water and sewage effluents. The two chlorinator stations on the Ware River watershed, one to chlorinate the sewage effluent from the treatment plant of the temporary Rutland Prison Camp and Hospital, and the other on Mill Brook below the Rutland State Sanatorium and the Central New England Sanatorium, were kept in condition for use but due to the fact that no water was required to be diverted at the Ware River intake works they were not operated.

### *Operation of Ware River Intake Works*

Maintenance of the Ware River intake works was continued. No water was diverted into the tunnel during the year. The tunnel was entered for inspection through Shaft 8 on January 17 and the doors of the steel bulkhead, 2,200 feet west of the shaft, were fastened open to prevent any possibility of damage to the hinges or fastenings when holing through between Shafts 8 and 9 at the heading about 2,800 feet further west. The main butterfly valves at the top of Shaft 8 were closed and the valve pit filled with water when the tunnel was holed through January 24. The blast was heard in the intake building but was not perceptible at the head house over Shaft 4. The next day the tunnel was again entered, the shaft, tunnel and bulkhead were found in good condition and the bulkhead doors were fastened in a closed position.

### *Miscellaneous Construction*

Minor alterations were made at the Wachusett outlet works consisting of the relocation of the temporary transformer platform. Additional shrubbery and trees from the Metropolitan District Commission nurseries in Stoneham and from private nurseries were transported to Shafts 1, 4 and 8 and transplanted.

A small labor force was employed throughout the year on miscellaneous work in caring for the grounds at the Ware River intake, Wachusett outlet and Shaft 4 head house, setting stone bounds, filling cellar holes, grading and cleaning up at the sites of buildings removed from the Ware River watershed and other miscellaneous work. The average number of men employed in this work was two and the maximum six.

### *Progress of Contracts*

*Contract 39.* — Bids were opened July 7 for constructing a trunk sewer in the towns of Rutland and Holden to a point of connection with the Worcester sewerage system. Ten bids were received for constructing the entire sewer ranging from \$184,327.50 to \$375,818.50, fifteen for constructing the east portion only, ranging



from \$109,341.50 to \$282,595.00, and seventeen for constructing the west portion only, ranging from \$86,546.50 to \$219,975.80. The contract for the entire sewer was executed July 11 with James J. Coughlan & Sons, Inc., Boston, the low bidder. The contractor established his field office in the village of Jefferson July 19 and commenced the clearing of the right of way July 25. Trench excavation was done by two 1-cubic yard back diggers. In addition a  $\frac{1}{2}$ -cubic yard clamshell bucket crane was used where ledge was encountered. The trench was excavated entirely by the open trench method, no sheeting or bracing being used. The machine diggers also handled the pipe into the trench, excavating the trench to grade only one 16-foot pipe length in advance of the laying of the pipe. Two bulldozers were used to assist in backfilling and one in pipe delivery.

The material for constructing embankments was obtained by the contractor from pits on private property as well as from lands of the Commonwealth. All foundation embankments were generally spread in 6-inch layers using two bulldozers and rolled by a 10-ton roller, this equipment being transferred to different points of the work as needed. Two 1-yard steam shovels were used in the borrow pits.

The first trench digging and pipe laying plant started laying pipe August 28 and the second September 20. A total length of 12,928 feet was laid, 7,692 feet by the first plant and 5,236 feet by the second. The average rate of pipe laying since August 1 was about 735 feet per week, the maximum in any one week being 2,239 feet.

At the Worcester Brook embankment, excavation of unsuitable foundation material was started August 14, at Asnebumskit Brook August 26, and at Eagle Lake September 6. At the end of the year these three embankments were practically completed except for soil dressing to an elevation well above the grade of the pipe so that a shallow trench will need to be excavated for the pipe. At the Newell Road embankment, excavation of unsuitable foundation material was started September 21. At the end of the year the embankment was about 40% completed.

Six reinforced concrete culverts were constructed between August 31 and November 16. A  $\frac{1}{2}$ -yard clamshell crane was used in excavating for the culverts and a 1-bag mixer was used for the concrete.

Nineteen of the required 129 manholes were constructed. Steel forms were used. The value of work included in contract estimates to November 29, the date of the latest estimate, was \$56,015.75, of which 90% was approved for payment. The contractor's force averaged forty-five men, the maximum being seventy-six for the week ending October 7.

The total work done and materials furnished to date under the principal items of Contract 39 are as follows:

Excavating and refilling trench . . . . .	11,430 lin. ft.
Earth excavation, except in trench . . . . .	10,510 cu. yds.
Rock excavation . . . . .	1,984 " "
Furnishing and laying 10-inch pipe . . . . .	4,946 lin. ft.
Furnishing and laying 12-inch pipe . . . . .	2,797 " "
Furnishing and laying 16-inch pipe . . . . .	5,067 " "
Foundation embankment . . . . .	21,425 cu. yds.
Concrete in manholes . . . . .	88 " "
Concrete, except in manholes . . . . .	421 " "

*Contract 42.* — Contract 42, an agreement with the City of Worcester, for the use of the Worcester sewerage and treatment works, for the disposal of sewage from Rutland and Holden, was executed May 1. Under this agreement the city constructed 2.11 miles of vitrified tile pipe sewer, mostly 15 and 18-inch, from the Holden-Worcester line to connect with the Worcester trunk system of sewers at a point on Salisbury Street about 1,600 feet north of Flagg Street. An inspection of the completed sewer was made by the division November 14. In accordance with the provisions of the agreement, the Commission paid the city a total of \$325,000 as compensation for the construction of the sewer within the city limits and for the right to enter the city's sewerage system and treatment works.

#### COLDBROOK-SWIFT TUNNEL DIVISION — HARDWICK OFFICE

The Coldbrook-Swift Tunnel Division continued in charge of the construction of the Coldbrook-Swift Tunnel section of Quabbin Aqueduct and of river surveys along the Ware, Swift and Chicopee rivers.



### *Office Work*

Tunnel cross sections were plotted and excavation and masonry volumes computed therefrom. Semi-monthly estimates were prepared for Contract 20. Topographic maps were made of areas on Danforth Brook, Prince River and at the tunnel spoil bank at Shaft 9. The preparation of geologic field notes and specimens for a permanent geologic record was continued.

### *Field Work*

Lines and grades were given for construction on Contract 20. About 430 acres of topography were taken along the Ware River and tributaries below the intake and about 25 acres in the vicinity of Shafts 9 and 12. About 35 acres at and in the vicinity of industrial plants on the Ware River were surveyed and cross sections taken of the river at various points near these plants. The State Department of Public Health continued its cooperation in the analysis of samples of drinking water used in the different contractors' camps. Test pits were dug to investigate the possibility of a gravity water supply for the future head house and service building at Shaft 12. Taking of samples of concrete for testing was continued and an analysis was made of rock crushed by the contractor at the various shafts to determine its fitness for tunnel concrete aggregates. Records were continued of the amount of cement used and required to be used at all points of the work. Photographs of the construction work and of rock formations of geological interest were continued. Geological investigations were continued in connection with the tunnel construction. The division also continued its cooperation with the Enfield office in geological investigations in connection with the diversion tunnel completed under Contract 30, the dike caisson core wall under Contract 36, surveys for the spillway and spillway channel at the main dam and for the new highway west of the proposed reservoir. Special castings for Contract 20 were inspected at the foundry.

A small labor force was employed from time to time constructing guard rail for the relocated highway near Shaft 12 and other miscellaneous work.

### *Collection of Stream Flow and Water Power Data*

The collection of data pertinent to the determination of the water power available and developed at various plants on the Ware, Swift and Chicopee rivers and to the determination of flows at various points under varying conditions, was continued. Recording stream gaging stations were continued at White Valley, Ware and Bircham Bend.

This office continued the investigations of the quality of the water in the Ware River made in cooperation with the laboratory at Enfield, the collection of the necessary hydraulic data in connection with this work being carried on by this office.

### *Progress of Contracts*

*Contract 20.* — Contract 20, for the construction of the Coldbrook-Swift Tunnel section of Quabbin Aqueduct, through the towns of Barre, Hardwick and Greenwich, continued in force throughout the year. This tunnel extends 10.4 miles from the end of the completed Wachusett-Coldbrook section to the Swift River intake in the town of Greenwich.

At the end of the year about 81% of the value of the work was completed. This included the completion of the tunnel excavation, a length of about 16,332 feet of tunnel being excavated during the year, making a total under this contract of 54,831 feet. It also included the lining with concrete of about 25,000 feet of tunnel. A length of about 29,862 feet of tunnel remains to be lined under this contract. The selection, crushing and screening of tunnel spoil for use as concrete aggregates were continued at all shafts. Concrete mixing plants were set up and operated at the top of Shafts 9 and 11 and the concrete was placed in sidewalls, arch and invert from four tunnel plants, one in each heading from each of these two shafts. A mixing plant was also being set up at the lower intake just outside the tunnel portal. Excellent progress continued to be made in the excavation of this hard rock tunnel. The average weekly excavation for the year in eight headings was 98.9 feet per heading. The maximum in one heading was 138 feet in the week ending April 8 in the east heading from Shaft 10. Only 1,202 feet of permanent timbering was required to be placed during the year, making a total of 1,590 feet of tunnel or 2.90%

of the length excavated under this contract, requiring permanent timbering. This makes a remarkably low total of 1,971 feet or 1.52% of the entire length, 24.6 miles, of Quabbin Aqueduct. The average weekly progress in placing concrete lining from four tunnel plants was 298 feet per plant. The contractor continued to employ local physicians who made weekly reports on the health of his employees and on the sanitary conditions at each of his camps and to employ a safety engineer for the improvement of working conditions in the tunnel. The excavation of the entire 10.4 miles of tunnel under this contract was completed with no fatal accidents.

The following is a summary of the difference in line and grade at the points where the excavations met between shafts.

Shaft	Distance Apart	Difference		Point of Meeting
		Line	Grade	
8- 9	12,412 ft.	.06 ft.	.06 ft.	4,998 ft. from Shaft 8
9-10	14,501 ft.	.63 ft.	.11 ft.	7,611 ft. from Shaft 9
10-11	15,840 ft.	.12 ft.	.02 ft.	8,278 ft. from Shaft 10
11-12	16,757 ft.	.10 ft.	.05 ft.	8,254 ft. from Shaft 11
12-Portal	319 ft.	.00 ft.	.02 ft.	230 ft. from Shaft 12

The value of work included in contract estimates during the year was \$1,552,245.20, or a total to November 24, the date of the latest estimate, of \$4,041,658.33, of which 90% was approved for payment.

Shaft 9. — Tunnel excavation was completed January 24, the lengths excavated being as follows:

Location	Year ending		Total
	To Nov. 30, 1932	Nov. 30, 1933	
East heading	6,587 ft.	827 ft.	7,414 ft.
West heading	6,678 ft.	933 ft.	7,611 ft.
Total	13,265 ft.	1,760 ft.	15,025 ft.

Tunnel driving was continued by the full-face method. The quality of the rock encountered varied considerably, a good deal of it being too soft to be used as concrete aggregates. In the east heading an additional 47 feet required permanent timbering; none being required in the west heading. An additional 117 feet of the tunnel roof in the west heading was treated with gunite to prevent weathering in the seams and scaling off. On January 24 the east heading was holed through to the west end of the previously completed Wachusett-Coldbrook section of Quabbin Aqueduct. Excavation in the west heading was then stopped and the doors in the steel bulkhead about 2,200 feet west of Shaft 8 were fastened in closed position to prevent any drainage from the contractor's operations in the tunnel from entering the Wachusett Reservoir by way of the completed section of the tunnel. The average weekly progress of tunnel excavation for the year was 110 feet easterly and 122 feet westerly, the maximum progress being in the week ending January 21, when 127 feet were excavated in the east section and 124 feet in the west section.

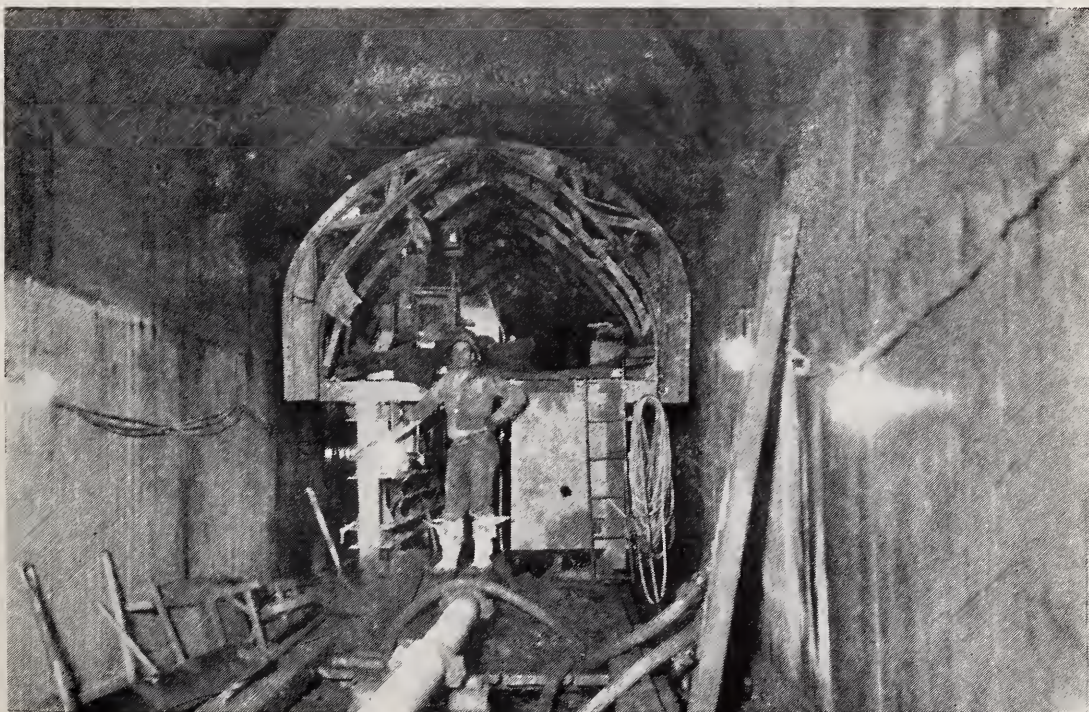
Final trimming and grading of the tunnel were commenced promptly upon the completion of excavation. The crushing, screening, washing and mixing plant was completed at the top of the shaft in April. To supplement the quantity of available material obtained from the tunnel excavation crushed stone and screenings were hauled from Shaft 10 and gravel and sand were obtained from a borrow pit adjacent to Shaft 9. Two tunnel lining plants were erected, one in the east heading at the junction with the previously lined Wachusett-Coldbrook section and one in the west heading 6,208 feet from the centerline of the shaft. On May 6 the first concrete was poured in the east heading and on June 6 in the west heading. Thereafter, except as interrupted for a brief time by labor difficulties, concreting was continued with good progress in both headings until November 13, at which time the lining from this shaft was completed with the exception of a length of 41 feet at the bottom of the shaft and an additional length of 463 feet of invert. The average weekly progress of the tunnel lining was 322 feet in the east heading and 326 feet in the west heading, the maximum being in the week ending June 24, 497 feet in the east heading and 499 feet in the west heading. The contractor's force averaged sixty-two men, the maximum being 124 during the week ending September 23. The average number of persons occupying the camp was fifteen, the maximum population being forty-one during the week ending August 26.

There was no material change in plant items required for the tunnel excavation. The surface plant for crushing and screening was similar in many respects to that





CONTRACT 20. — Coldbrook-Swift Section of Quabbin Aqueduct, Permanent Timbering in the West Heading at Shaft 9.



CONTRACT 20. — Coldbrook-Swift Section of Quabbin Aqueduct, Arch Forms for Tunnel Lining at Shaft 11.





used by the contractors on the Wachusett-Coldbrook section. The same dragline scraper operated over the spoil bank to bring the material to a grizzly, from which a short conveyor-belt carried the material to a screening and washing plant, using the same rotary screen. Fine particles in suspension were carried to settling basins beyond the muck piles where the water was clarified. Material of suitable size for aggregate was carried by conveyor-belts to the stone and sand storage piles. The screens fed the coarse material into a crusher from which it was returned to the screen. A heavy timbered trap tunnel under the two aggregate storage piles was used, the same as on the Wachusett-Coldbrook section. However, instead of batching the aggregates and dropping them dry down the shaft, all concrete was mixed at the surface in two 1-cubic yard mixers, the cement, sand and stone being proportioned by weight for each batch and the water by tank measurement. Bulk cement was shipped in containers holding about twenty-five barrels each, twelve in a car. These containers were emptied through bottom doors into the contractor's bin near the railroad siding, holding about six hundred barrels. Specially-constructed trucks carried the cement to the shaft where it was stored and weighed as required for the mixer. Each batch was emptied into a small hopper from which it dropped down the shaft through an 8-inch pipe to a hopper at the bottom, from which the cars were filled by a hand-operated shutter. The concrete cars were of steel specially designed with the bottom slanting about 45° to one side which was hinged at the top. This swinging side closed against a rubber gasket, giving a water-tight joint. A train consisted of four cars, each holding two batches. The tunnel plant used for placing concrete lining differed in many respects from that used on the Wachusett-Coldbrook section. The contractor purchased the tunnel forms used on the latter section and rebuilt them by cutting them into two sections, the sidewall forms to about 2 ft. 2 in. below the springing line of the finished arch, being set up in advance of the arch forms. All forms in use were carried ahead on a jumbo in one operation instead of being collapsed in sections and telescoped from end to end of the work as was the case in the Wachusett-Coldbrook section. Also the placing of the invert, instead of being an entirely separate operation, followed immediately after the placing of sidewalls and arch. As rebuilt, the forms consisted of 125 feet of sidewall forms followed by 125 feet of arch forms and preceded by an incline about 60 feet long, the whole supported on wheels on a 6 ft. 6 in. gage track, accurately placed to line and grade. This track was of rails spiked to 6 in. x 10 in. longitudinal stringers, which were picked up in sections from behind the forms, passed forward and relaid in front. A working platform at about mid height of the tunnel was reached by the incline ahead of the sidewall forms. A concrete gun used for placing the arch and invert concrete was hung under the platform and fed through a steel hopper of about 1 cubic yard capacity set in the platform. The sidewall forms were filled by dumping directly from the concrete cars. The arch forms were raised and lowered by oil-operated jacks. The sidewall forms moved in and out by turnbuckles. The arch concrete was placed through a 6-inch line from the concrete gun carried along the working platform and extended up through first one and then another of a series of trap doors in the arch forms. The invert was also cast by the use of a gun and pipe removed in sections as the work progressed. The invert was screeded by steel templets, guided by a 3-inch ledge previously cast with the sidewall at the elevation of the intersection with the invert. Except as above described, no important items of plant were added during the year. The largest pump in use had a rated capacity of 2,000 gals. per min. under 300-ft. head driven by a 200-horsepower motor. The combined compressor capacity was reduced after the completion of excavation to 1,100 cu. ft. per min.

Shaft 10. — Tunnel excavation was completed on October 16, the lengths excavated being as follows:

Location	To Nov. 30, 1932	Year ending Nov. 30, 1933	Total
East heading . . . . .	3,810 ft.	3,080 ft.	6,890 ft.
West heading . . . . .	3,797 ft.	4,481 ft.	8,278 ft.
Total . . . . .	7,607 ft.	7,561 ft.	15,168 ft.

Tunnel driving was continued by the full face method. In the east heading an additional 903 feet required permanent timbering, 22 feet required temporary timbering and 1,010 feet of the tunnel roof was treated with gunite to prevent

weathering in the seams and scaling off. In the west heading 609 feet of the tunnel roof was treated with gunite. On August 10 the east heading was drilled through into the west heading from Shaft 9, leaving a 7-foot plug of rock to cut off water drainage and air circulation. This plug was holed through October 15 and on October 16 the west heading was holed through into the east heading from Shaft 11. The average weekly progress of tunnel excavation for the year was 86 feet easterly and 101 feet westerly, the maximum progress being in the week ending April 22, when 137 feet were excavated in the east section and 104 feet in the west section.

After holing through, all work at this shaft was discontinued except pumping which was continued until November 21. The contractor's force averaged sixty-five men, the maximum being ninety during the week ending January 7. The average number of persons occupying the camp was sixteen, the maximum population being twenty-nine during the weeks ending December 17 and January 21.

There was no material change in plant items during the year. The largest pump in use had a rated capacity of 1,100 gals. per min. under 450-ft. head driven by a 200-horsepower motor.

*Shaft 11.* — Tunnel excavation was completed April 20, the lengths excavated being as follows:

	Location	To Nov. 30, 1932	Year ending Nov. 30, 1932	Total
East heading	.	5,843 ft.	1,719 ft.	7,562 ft.
West heading	.	6,193 ft.	2,061 ft.	8,254 ft.
Total	.	12,036 ft.	3,780 ft.	15,816 ft.

Tunnel driving was continued by the full face method. In the east heading 252 feet required permanent timbering. The average weekly progress of tunnel excavation for the year was 86 feet easterly and 103 feet westerly; the maximum progress being in the weeks ending December 10 and February 25, when a total of 221 feet was excavated in both headings. The final trimming and grading of the tunnel was commenced promptly upon the completion of excavation and two tunnel lining plants were erected, one in the east heading 7,300 feet from the centerline of Shaft 11 and one in the west heading 7,952 feet from the shaft. The crushing, screening and washing plant was set up early in the year and used for experimentation on the quality of the aggregates until concreting was started at the shaft. On July 3 the first concrete was poured in the west heading and on August 22 in the east heading. On September 19, after the tunnel excavation had been holed through from Shaft 12, a bulkhead was constructed between Shafts 11 and 12 to cut off the circulation of cold air. At the end of the year the lining had been carried to within 2,621 feet of the shaft easterly and 1,249 feet westerly. The average weekly progress of the tunnel lining was 331 feet in the east heading and 389 feet in the west heading, the maximum being in the weeks ending October 28 and November 11, 525 feet in the east heading and 524 feet in the west heading. The contractor's force averaged seventy-nine men, the maximum being 140 during the week ending October 14. The average number of persons occupying the camp was twenty-three, the maximum population being forty-seven during the week ending September 16.

Except for the tunnel lining equipment, there was no material change in plant items during the year. The screening, washing and mixing plant and the tunnel lining plant were similar to that used at Shaft 9 and previously described. The largest pump in use had a rated capacity of 1,000 gals. per min. under 350-ft. head driven by a 150-horsepower motor.

*Shaft 12 and Swift River Intake.* — Tunnel excavation was completed June 23, the lengths excavated being as follows:

	Location	To Nov. 30, 1932	Year ending Nov. 30, 1932	Total
East heading	.	5,330 ft.	3,173 ft.	8,503 ft.
West heading	.	172 ft.	58 ft.	230 ft.
Portal	.	89 ft.	0 ft.	89 ft.
Total	.	5,591 ft.	3,231 ft.	8,822 ft.

Tunnel driving was continued in the east heading by the full face method.

On June 14 the east heading was holed through to the west heading from Shaft 11. The remaining 58 feet in the west heading was then excavated by the heading and



bench method, holing through to the portal June 23. The average weekly progress of tunnel excavation for the year was 113 feet (in the east heading), the maximum progress being 134 feet during the week ending December 17, 1932.

Spoil from the tunnel excavation continued to be used to cover swampy areas in the vicinity of the lower intake and as additional riprap along the sides of the lower intake channel. Tunnel spoil was also used for building the temporary relocation of the highway just east of the shaft at an elevation above the future flow line of Quabbin Reservoir. Guard posts were set along the new highway location. Castings for stop log grooves to be installed in the shaft were delivered at the site, commencing the middle of June.

After holing through, all work in the tunnel at this shaft was discontinued except pumping. Beginning August 5, the contractor resumed with a small force, the erection of the crushing, screening, washing and mixing plant, using equipment transferred from Shaft 9. This plant is being located at a point above the cut and cover section of the lower intake just west of the tunnel portal in preparation for tunnel lining operations. The contractor's force averaged thirty-three men for the year and fifty until June 14, the maximum being fifty-three in the four weeks ending January 14, April 8, May 13 and 20. The average number of persons occupying the camp was nine, the maximum population being twenty-one during the week ending February 11.

There was no material change in plant items for the tunnel excavation. At the end of the year the contractor was engaged in installing additional equipment for tunnel lining including that transferred from Shaft 9. The largest pump in use had a rated capacity of 650 gals. per min. under 150-ft. head driven by a 75-horsepower motor. The combined compressor capacity was reduced to 750 cu. ft. per min.

The total work done and materials furnished to date under the principal items of Contract 20 are as follows:

	Shaft 9	Shaft 10	Shaft 11	Shaft 12 and Intake
Earth excavation for shafts (cu. yds.)	84	318	225	*
Rock excavation in shafts and in tunnel within 50 ft. of shafts (cu. yds.)	2,310	3,617	2,660	1,445
Excavation in tunnel, except within 50 ft. of shafts (cu. yds.)	101,254	99,970	105,264	58,019
Shaft and tunnel drainage (lin. ft.)	11,281	4,090	9,214	2,241
Earth excavation in open cut (cu. yds.)	—	2,500	1,803	35,729
Rock excavation in open cut (cu. yds.)	—	435	106	2,181
Forms for concrete lining in shafts (lin. ft.)	178	397	258	—
Forms for concrete lining in tunnel (lin. ft.)	13,612	—	10,633	—
Concrete masonry in shafts (cu. yds.)	400	929	611	—
Concrete masonry in tunnel (cu. yds.)	28,343	—	22,461	—
Concrete masonry not in shafts or tunnel (cu. yds.)	—	—	1	1,062
Permanent timbering in tunnel (M ft. B. M.)	34	215	54	25
Temporary timbering in tunnel (M ft. B. M.)	7	—	4.5	—
Portland cement (bbls.)	45,935	1,909	35,874	2,212
Guniting protective coating of tunnel rock (lin. ft.)	3,648	3,453	—	—
Refilling and embanking (cu. yds.)	—	1,625	—	2,753
Miscellaneous cast iron, wrought iron and steel (lbs.)	23,400	3,415	—	9,251
Riprap (cu. yds.)	—	—	—	822
Paving (cu. yds.)	—	—	—	21

\*Included in item, "Earth excavation in open cut."

Electric power for all contract requirements was purchased by the contractor. The total consumed at the different shafts during the year was as follows:

	K.W.H.
Shaft 9 . . . . .	1,330,200
Shaft 10 . . . . .	3,084,869
Shaft 11 . . . . .	3,104,400
Shaft 12 . . . . .	1,141,400
Total . . . . .	8,660,869

The total electrical power consumed on Contract 20 from April 23, 1931, to November 30, 1933, was approximately 19,048,000 kilowatt hours, the total length of tunnel excavated being 54,831 linear feet and the total length of tunnel lined being about 25,000 linear feet.

#### QUABBIN RESERVOIR DIVISION — ENFIELD OFFICE

The Quabbin Reservoir Division continued in charge of the field work in the Swift River valley in connection with the proposed Quabbin Reservoir including topographic and real estate surveys, cemetery removal work, and the soil testing

and water analysis laboratories. The division also continued in charge of construction work at the main dam and dike sites and was in charge of the construction of the Belchertown-Pelham highway and its extensions and of the relocation of the high tension transmission line of the New England Power Company.

#### *Miscellaneous Office Work*

Semi-monthly estimates for Contracts 36 and 41, monthly estimates for Contracts 23, 30, 40 and 43, and a final estimate for Contract 30 were prepared. For contract use and also for submission to the State Department of Public Works and the County Commissioners of Hampshire and Franklin Counties, plans were prepared of the relocated Belchertown-Pelham highway and its extensions to and north of New Salem, except for a section between Cooleyville and New Salem Center which was in charge of the Holden office. The new location follows closely the existing highway from Belchertown through Pelham Center to a point about 1 mile north of the Pelham-Shutesbury line. The new route then runs northeasterly and crosses the west branch of the Swift River about 0.7-mile downstream from its crossing of the Cooleyville-Shutesbury highway. It then passes close to the southerly side of the village of Cooleyville and continues northeasterly over the top of New Salem hill about 0.1-mile northerly of New Salem Center and crosses the Millington-North New Salem highway about 0.8-mile southerly of North New Salem village. Thence it extends easterly across the middle branch of the Swift River and northeasterly again along the Millington-Orange highway to a point just north of the New Salem-Orange town line at the junction with a highway to Athol. The new highway will have a 24-foot bituminous macadam surface with 3-foot gravel shoulders.

Real estate plans were prepared along the entire line of the relocated Belchertown-Pelham highway and extensions. Revised topographic plans of the main dam site were made. Photographs of the progress of construction carried on under the supervision of this and other divisions were taken by this division. Meteorological records at Enfield were continued.

#### *Miscellaneous Field Work*

Lines and grades were given for construction on Contracts 23, 30, 36, 40, 41, 43 and 44. A detailed topographic survey was made for use in a contract for a caisson core wall at the main dam site. Pumping from the exploratory caisson at the dike site was continued until January 21, when the lowering of the ground water level at the dike site was taken over by the contractor for the construction of the caisson core wall. Holes were drilled through the concrete walls of the experimental caisson at the main dam site and piping installed to increase the intake capacity. Additional electric wiring and pumping equipment were installed in the caisson. The pipe line for the discharge from the pumps was extended underneath the railroad track to a weir box constructed on the bank of the old river bed from which the river had been diverted by low cofferdams constructed under Contract 30. The pumps in the caisson were again operated for the lowering of the ground water level, commencing August 14. Commencing November 1, work was begun on the construction of a further extension of the discharge line from the pumps to a point above the upstream cofferdam. Daily readings of ground water level in numerous test wells were taken during the pumping operations at the dike and the dam. Additional topographic and real estate surveys and cross sections were made for the location of the new highway west of Quabbin Reservoir and additional test pits were dug to determine material suitable for their construction. Sub-surface investigations were made by test pits at and near sites proposed for the main dam spillway and spillway channel on both the east and west sides of the valley. In the late summer, repairs were made on the dam across the Swift River at Enfield. New roof trusses, roof and other repairs were made on the garage in Enfield formerly known as Coolbeth's Garage which was gutted by fire March 6. This garage is used for garaging trucks and other equipment attached to this division and equipment of the Department of Public Works.

In connection with new highway construction, a narrow section along the easterly side of the Pelham Center Cemetery was relocated in an area of 0.4-acre



### Reservoir — General

*Fire Protection.*—The fire fighting equipment was continued in readiness for service at all times. Five assistants in the division office were reappointed as deputy forest wardens in each of the towns affected by the reservoir. The equipment and personnel responded during the year to calls for assistance at fourteen forest fires which burned over a total area of fifty-nine and one-half acres. The apparatus also responded to fires in fourteen buildings.

### Laboratories

*Soil Testing Laboratory.* — The work of exploring, collecting and testing materials to determine their suitability for use in the construction of the proposed main dam and dike was continued and included analyses of the results of the tests conducted in a sluicing bin constructed in the yard of the old Tebo mill in Enfield on the south bank of the Swift River. These sluicing tests were begun September 1, using material from a proposed borrow area northwesterly of the dike site. Tests were continued, using material also from a proposed borrow area northeasterly of the dam site. New equipment was added to the laboratory as testing methods were expanded to include new studies and to keep pace with current developments in soil engineering. Investigations were continued of the glacial deposits on the west side of Beaver Brook valley north of the dike site and on both sides of the Swift River north of the main dam site. Tests were made of top soils stripped from the site of the dike foundation under Contract 36 to determine their suitability for impervious refill of the core wall trench. Tests were also made of top soils to be removed from the site of the main dam foundation and of samples of top soil from other areas below the reservoir flow line to determine their suitability for impervious refill in the construction of the main dam. Sand and gravel for concrete aggregates were tested from the test pits and aggregate plant used on Contract 36.

*Chemical and Bacteriological Laboratory.* — The collecting and analyzing of water samples were continued in cooperation with the headquarters office and with assistants from the Coldbrook-Swift Tunnel Division. Samples of the water supplies of contractors engaged on work in this and other divisions and of miscellaneous supplies on property controlled by the Commission were collected and analyzed periodically.

### Progress of Contracts

*Contract 23.* — Contract 23, for making borings in the towns of Belchertown, Enfield, Ware, Greenwich and Hardwick, continued in force throughout the year. The work was confined to the exploration of overburden in the vicinity of the main dam, the sinking of wells for the observation of ground water levels and the location of ledge at the proposed spillway sites.

The value of work included in contract estimates during the year was \$12,019.91 or a total to November 10, the date of the latest estimate, of \$42,793.16, of which 90% was approved for payment. The contractor had one drilling rig in operation during the year and employed an average of two men.

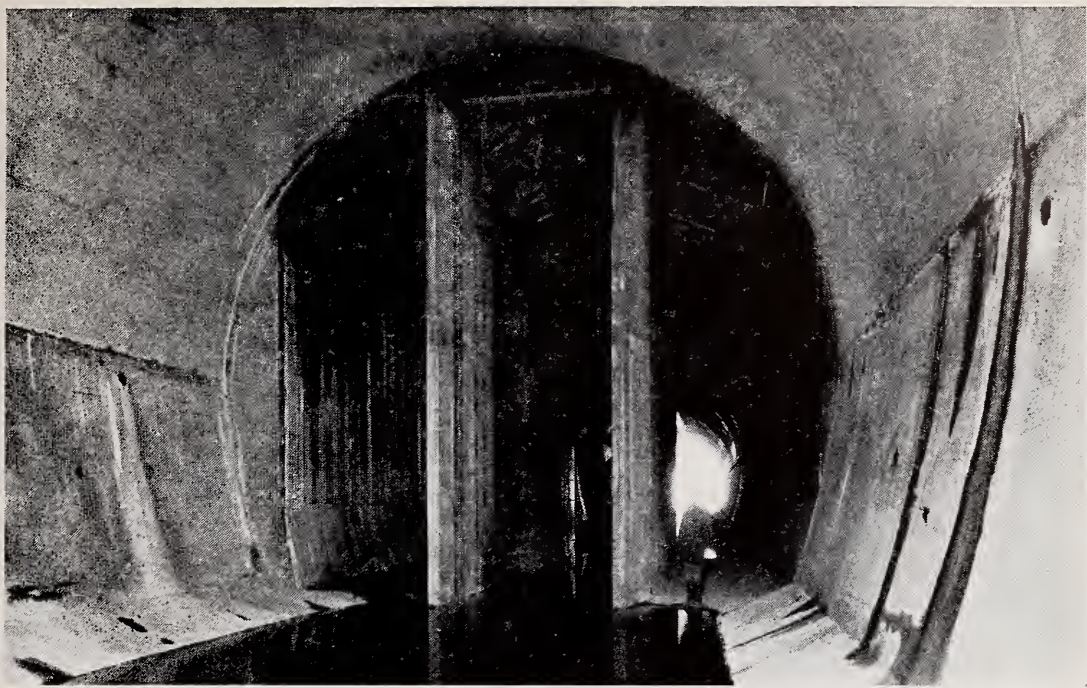
*Contract 30.* — Contract 30, for constructing the stream control works at the main dam of Quabbin Reservoir in the towns of Belchertown, Enfield and Ware, was continued to completion. Grouting the sidewalls and roof of the tunnel and shaft was started January 22 and completed February 23. On February 8 all work in the tunnel was completed, the tunnel cleaned and pumping equipment removed. Work was discontinued from February 23 to April 24. Riprap and paving around the upstream portal was completed May 20. The approach and outlet channel was excavated through to the river June 2 and the placing of riprap at the inlet to the approach channel was completed June 8. Complete diversion from the old river bed was effected June 7 by the construction of small earth cofferdams at the ends of the approach and outlet channels and all work under the contract was completed July 1.

The value of work included in contract estimates during the year was \$73,125.45, the final estimate dated August 29, being \$544,610.60. The contractor's force averaged nineteen men, the maximum being sixty-three on December 2, 1932. The contractor's camp was discontinued February 1. No important items of plant were added during the year.

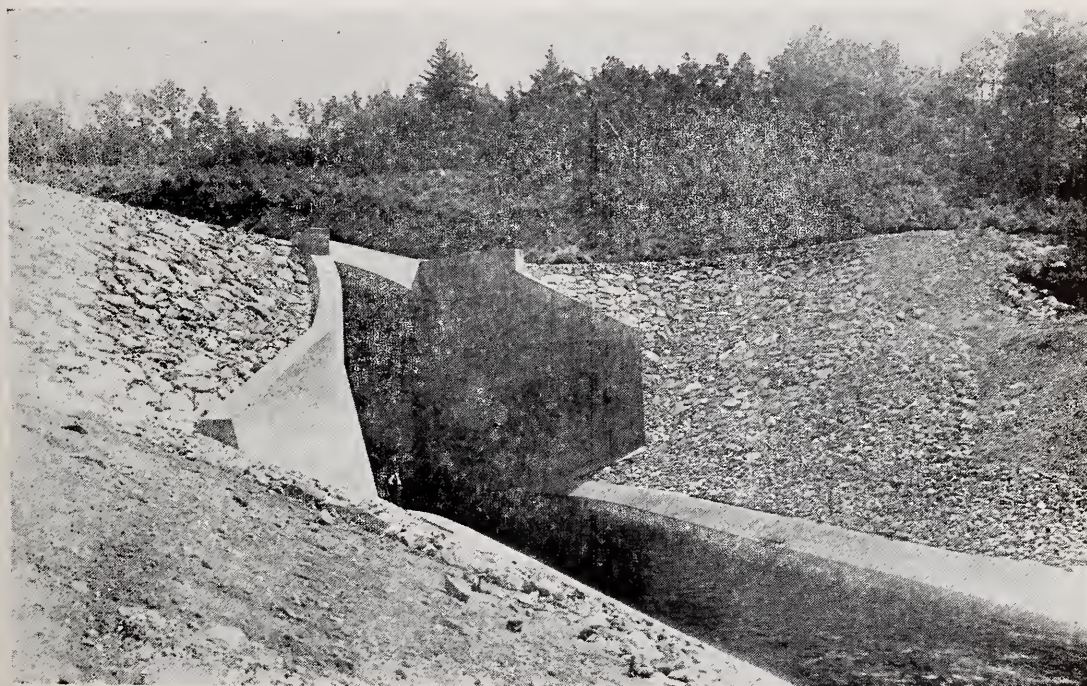
The total work done and materials furnished under the principal items of Contract 30 are as follows:

Excavation in shaft and tunnel	38,347 cu yds.
Earth excavation in open cut	289,160 "
Rock excavation in open cut	23,522 "
Refilling and embanking compacted in 6-inch layers	139,252 "
Other refilling and embanking	132,547 "
Concrete masonry in tunnel and open-cut conduit	21,183 "
Portland cement	32,131 bbls.
Cast-iron pipe and miscellaneous iron and steel	92,574 lbs.
Riprap	917 cu. yds.
Paving	793 "
48-inch Conduit	951 lin. ft.





CONTRACT 30. — Main Dam River Diversion Tunnel, Looking Upstream between Piers at the Foot of Shaft.



CONTRACT 30. — Main Dam River Diversion Tunnel, Upstream Portal and Concrete Lined Approach Channel.





*Contract 35.* — Contract 35, with the New England Power Company, for the purchase of electricity for experimental work at the dam site, was continued in force throughout the year. Electric power was purchased for use in experimental pumping. The total power furnished was 151,000 kilowatt-hours, costing \$3,020, during the year.

*Contract 36.* — Bids were opened December 9, 1932, for constructing a core wall to sound rock at the site of the dike of Quabbin Reservoir in the towns of Enfield and Ware. Twenty-five bids were received ranging from \$995,265.00 to \$2,344,177.00. The contract was executed December 28, 1932, with the West Construction Company, the low bidder, who was the contractor on the completed Wachusett-Coldbrook tunnel section of Quabbin Aqueduct. As previously explained, the work consists mainly of excavating an open trench across the valley 40 feet below the level of Beaver Brook, sinking a row of thirty-one concrete caissons from the bottom of this trench to sound rock, and refilling both caissons and trench with impervious materials. On January 16 work on the access road from the main highway was started with one gasoline shovel. On January 17, two gasoline shovels started stripping the site of the open trench and cofferdams. The excavation of the main cut was kept well in advance of the placing of the caisson shoes which were generally set at the grade of the bottom of the open-cut trench specified for payment. Suitable impervious material from the stripping was stored for later use in refilling the open trench. Suitable pervious materials were placed in the cofferdams and spread by a bulldozer in 6-inch layers, wetted and rolled with a 14-ton gasoline roller with bands on the rear rollers. Material too coarse to be placed in this manner was carefully puddled and rolled. Material too fine for use in the cofferdams or elsewhere in the completed structure was wasted in spoil areas downstream from the site. A considerable quantity of fine material was so wasted but sufficient material suitable for the construction of the toes of the future embankment was excavated so that by the end of the year the downstream cofferdam was completed to elevation 430 and the upstream to 438. The original brook level was about elevation 416. The pumps in the exploratory caisson, numbered 13, which had been operated by the Commission since the completion of Contract 32, were taken over by the contractor January 21 and their capacity increased to 3,200 gallons per minute. Pumping from this caisson was maintained continuously, using the intakes provided in the permanent seal to ledge and additional pumping was done from the working chambers of other caissons during the sinking operations and from caisson 16 through intakes constructed in the permanent seal to rock. The total rate from all these pumps has averaged about 3,200 gallons per minute. The natural slope of the original bed, of the brook flowing past the site from Morton Pond about 1,200 feet upstream, is about 1.5 feet per thousand. The ground water level has been lowered as follows:

Location	To Nov. 30, 1932	Year ending Nov. 30, 1933	Total
At Core Wall (Caisson 13)	41 ft.	55 ft.	96 ft.
220 ft. upstream	27 ft.	28 ft.	55 ft.
800 ft. upstream	17 ft.	20 ft.	37 ft.
2,350 ft. upstream	2 ft.	16 ft.	18 ft.
Morton Pond			
(lowered by the underdraining operations)	2 ft.	6 ft.	8 ft.
1,050 ft. downstream	11 ft.	24 ft.	35 ft.
2,050 ft. downstream	2 ft.	12 ft.	14 ft.

The contractor is paid for caisson excavation at bid prices for the yardage between fixed elevations, independent of the air pressure required, and is paid for pumping not at a bid price but at a fixed price of 10 cents per million-foot gallons.

The first caisson, No. 18, the steel shoe of which was set March 22, was started at an elevation just above the original brook level and was sunk to a depth of 48 feet before it was necessary to add the air locks. The contractor then continued first with the caissons in the east half of the valley, sinking first every alternate caisson and later the intermediate ones. Each caisson was sunk by open excavation as deep as possible, then under air to sound rock. Then underpinning was placed, the rock cleaned and the caisson sealed against the water pressure by filling the working chamber to a height of 3.5 feet above the cutting edge, leaving the remaining concrete in the chamber to be poured after the completion of grouting operations. In each case the underpinning and sealing to rock was started at the uphill

end of the caisson and extended a little more than half the length of the caisson, the seal not being completed until the next adjoining caisson on the lower or downhill side had been seated on sound ledge. By this method the rock was thoroughly cleaned and the concrete seal carried through to the adjoining caisson, thus simplifying the work of filling the bottoms of the end joints between caissons.

The contractor was permitted to place three more caissons than originally planned, two on the east and one on the west end, in lieu of extending the core wall in sheeted trench excavation. At the end of the year all caissons had been started. Sixteen caissons, in addition to the exploratory caisson, were sunk to bed rock and sealed, except for grouting. 1,819 feet of sinking below the ordered bottom of the open-cut trench or 85% of the estimated total was completed, of which 1,472 feet was by open excavation and 347 feet under compressed air. The average rate of sinking in the open was 8.63 feet in twenty-four hours and under air 2.51 feet. The ground water was lowered to such an extent that although the maximum depth of sinking below the original ground water level was 127 feet, a pressure in excess of 18 lbs. per square inch was exceeded but once, namely, for three days, in caisson 16, which was sunk in advance of the lowering of the ground water level to such an extent that the maximum pressure was 22 lbs. Caisson 14, adjacent to the exploratory caisson, was sealed to ledge under 16 lbs., 32 lbs. less than was required for the sinking of the exploratory caisson under Contract 32 when the only means available for lowering the water level was by pumping from an open sheeted sump about 100 feet from the caisson.

After two adjacent caissons were sealed to ledge, the end joints between them were excavated by sheeting across the gap down to the water level and filling the gap with concrete. Ten of these end joints were completed on the easterly end of the core wall entirely by open excavation. The two joints between caissons 13 and 14 and between 14 and 15 required, in order to reach the bottom, the installation of small air locks, on top of a 3-foot shaft left in the joint which had previously been excavated and concreted to ground water level. To complete the easterly end a short length of core wall was constructed in open trench and a concrete mat 20 feet wide was placed on the ledge for a further distance of 95 feet, the limit of work required under this contract. Grout holes were drilled in general about 8 feet apart and extended 15 feet into the ledge and grouting was done under pressures not exceeding 15 lbs. At the end of the year grouting under the blanket at the east end was completed and drilling and grouting through the sealed caissons into bed rock was in progress.

Aggregates for concrete were obtained from a gravel deposit on land of the Commonwealth about one mile downstream from the site and hauled by truck to a central plant located immediately below the dike site. Here it was crushed, screened, washed and stored for use in batching. Bulk cement was hauled to this plant from the railroad siding at West Ware. Two 5-cubic yard transit mixers received the aggregate, cement and water, weighed and measured at the batching plant, and mixed the concrete en route to the caissons where the concrete was placed in steel forms by a crane and bucket. The forms were erected in 8-foot lifts and two lifts of about 210 cubic yards were poured daily. At the end of the year about 94% of the caisson concrete was poured.

An engineering office was constructed just downstream from the site in a location which will satisfactorily serve the work to be done under other contracts in the construction of the dike embankment and this office will be retained by the Commission for such future use.

The value of work included in contract estimates to November 20, the date of the latest estimate, was \$673,814.95, of which 90% was approved for payment. The contractor's force averaged 159 men, the maximum being 313 on May 23. The average number of persons occupying the camp was thirty-four, the maximum population being fifty during the week ending May 15.

The principal items of plant were as follows:

- 3 Gasoline shovels
- 3 Traveling cranes, 2 gasoline and 1 Diesel
- 2 Bulldozers
- 2 14-ton gasoline rollers
- 1 Crushing, screening and washing plant





CONTRACT 36. — Dike Core Wall, in the Working Chamber of Caisson 28.



CONTRACT 36. — Dike Core Wall, General View of Caisson Sinking East of the Exploratory Caisson Number 13 in Foreground which was Sunk under Contract 32. Top of Future Dike Embankment indicated by Batter Boards on Hill at Left. Transmission Line Towers in Background Removed under Contract 40.





- 1 Aggremeter
- 2 5-cubic yard transit mixers
- 3 Low pressure air compressors, total capacity 2,550 cu. ft. per min.
- 1 High pressure air compressor, total capacity 500 cu. ft. per min.
- 32 Ft. height of steel caisson forms
- 2 Man locks
- 4 Muck locks
- 1 Hospital lock
- 10 Pumps, each 800 gals. per min. at 90 ft. head
- 1 Service pump, 100 gals. per min. at 197 ft. head
- Trucks, hoists, portable compressor, etc.

The total work done and materials furnished to date under the principal items of Contract 36 are as follows:

Earth excavation in open cut to elevation 400	222,200 cu. yds.
Earth excavation in open cut below elevation 400	47,500 " "
Rock excavation as boulders in open cut	1,428 " "
Rock excavation as ledge in open cut	1,790 " "
Stripping	58,800 " "
Unconsolidated embankment	29,000 " "
Consolidated pervious embankment	202,100 " "
Rolled impervious embankment	3,450 " "
Pumping	119,200 mil.-ft.-gals.
Earth excavation for core wall, bottom of open cut to elevation 310	25,670 cu. yds.
Earth excavation for core wall below elevation 310	480 " "
Rock excavation in caissons to elevation 310	1,584 " "
Rock excavation in caissons below elevation 310	348 " "
Concrete not placed under air pressure	32,464 " "
Concrete placed under air pressure	1,830 " "
Portland cement	55,100 bbls.

*Contract 37.* — Contract 37, for the purchase of electricity to continue pumping operations begun under Contract 32 at the dike site in Enfield, was continued to completion. Electric power was supplied to continue the operation of pumps which had been installed in the exploratory caisson at the dike for the purpose of lowering the ground water prior to work to be done under Contract 36. Contract 37 was terminated January 21, at which time the West Construction Company took over the maintenance of pumping in the exploratory caisson in accordance with the terms of Contract 36.

During the year a total of 71,900 kilowatt hours were furnished, making the total during the contract 167,400 kilowatt hours. The cost of electricity furnished during the year was \$1,438, making the total cost from September 21, 1932, to January 21, \$3,348.

*Contract 40.* — Contract 40, for the removal and relocation of transmission and telephone lines and substation, in the towns of New Salem, Belchertown, Enfield and Ware, was executed June 20 with the New England Power Company and the Central Massachusetts Electric Company. Work was started July 10. Material from the old line was salvaged and used as far as possible in the relocated line. After clearing the new right of way and erecting all the required new towers the two 66,000-volt circuits were killed, the towers dismantled and re-erected in the relocated line and the copper in the old line salvaged. One 66,000-volt circuit was first strung on the new towers and energized October 27. The new substation in Belchertown was then completed and the second high tension line strung and a portion of it energized at 22,000-volts to maintain local service to Enfield and Belchertown while the old 22,000-volt line was being relocated. Finally the local service was carried on the relocated 22,000-volt line and the second 66,000-volt circuit was energized. The new 22,000-volt substation in Belchertown was put into active service November 12. Only preliminary work on the raising of the 110,000-volt line in New Salem was done. At the end of the year the contract was about 90% completed.

The value of work included in contract estimates to November 17, the date of the latest estimate, was \$68,046.10. The contractor's force averaged eighty men, the maximum force being 124 on October 6.

*Contract 41.* — Bids were opened July 18 for constructing a portion of the Belchertown-Pelham highway in the towns of Belchertown and Pelham, Hampshire County. Fourteen bids were received ranging from \$222,335.50 to \$356,680.30. The contract was executed July 20, with Carlo Bianchi and Company, Inc., Framingham, the low bidder. The Department of Public Works is cooperating in the

construction of this new state highway, paying a portion of the cost, namely, the cost of surfacing, guard rails and traffic signal ducts.

This contract is for 9.1 miles of bituminous macadam highway extending from a point 0.6-mile north of Belchertown Center to the Pelham-Shutesbury line, being the southern portion of the new west highway from Belchertown through New Salem, previously described. Work was started July 26. At the end of the year the grading, drainage, gravel base and bituminous macadam surface was practically completed for a distance of about  $3\frac{1}{3}$  miles at the Belchertown end, and about  $\frac{1}{4}$ -mile north of the Belchertown line in Pelham. Grading of the sub-base was completed for a distance of about 2 miles in Pelham and for about 50% of the remaining distance to the upper end of the contract at the Pelham-Shutesbury line. About 80% of the required drainage was installed. Of the larger concrete structures, one 4' x 6' cattle pass and one 8' x 4' box culvert were completed. Work of placing broken stone, which was delivered by truck from a quarry in Amherst, was started September 16, and finished for the season October 27. Stone was laid in two courses, a bottom course being 4 inches thick bound by sand, and a top course  $2\frac{1}{2}$  inches thick penetrated and sealed with asphalt. Asphalt penetration was started September 27 and completed for the season November 3. Inspection of the stone surfacing and asphalt applications was made by the District Engineer's Office of the Department of Public Works.

At the end of the year the work was about 50% completed.

The value of work included in contract estimates to November 29, the date of the latest estimate, was \$98,795.15, of which \$35,664 was assumed by the Department of Public Works, covering surfacing items. Of the remaining \$63,131.15, 85% was approved for payment. The contractor's force averaged eighty-six men, the maximum being 133 on October 20.

The principal items of plant were as follows:

- 6 Shovels, steam and gasoline
  - 5 Bulldozers
  - 4 Road rollers
  - 2 Road graders
- An average of 14 trucks, 5 to  $7\frac{1}{2}$ -tons.

*Contract 43.* — Bids were opened August 11, for constructing an extension of the Belchertown-Pelham highway to New Salem Center in the towns of Shutesbury and New Salem, Franklin County. Seven bids were received ranging from \$276,407.00 to \$379,772.50. The contract was executed August 25, with V. Barletta Company, Roslindale, for \$300,397.50. The Department of Public Works is cooperating in the construction of this new state highway, paying a portion of the cost, namely, the cost of surfacing, guard rails and traffic signal ducts.

This contract is for 7.6 miles of bituminous macadam highway extending from the Pelham-Shutesbury line to a point just north of New Salem Center, being the central portion of the new west highway from Belchertown through New Salem, previously described. The work of clearing was started August 29. Excavation for grading was started September 1, and during the month of September, five shovels were placed on the work. In October, two more shovels were added and rapid progress made on the work of excavation. At the end of the year about 55% of the excavation was completed and grading was completed for a distance of about  $4\frac{1}{6}$  miles, extending through Cooleyville from the Prescott-Shutesbury highway in Shutesbury to a point about  $1\frac{1}{2}$  miles south of New Salem Center. About 75% of the drainage through the areas of fill was completed. Six inches of gravel sub-base has been placed at various points for a total distance of about  $1\frac{1}{2}$  miles.

The value of work included in contract estimates to November 25, the date of the latest estimate, was \$65,053.50, of which 85% was approved for payment. The contractor's force averaged thirty-six men, the maximum being seventy on September 16.

The principal items of plant were as follows:

- 7 Gasoline shovels
- 4 Bulldozers

*Contract 44.* — Bids were opened November 10, for constructing an extension of the Belchertown-Pelham highway north of New Salem Center in the towns of New Salem and Orange, Franklin County. Nine bids were received ranging from



\$179,480.50 to \$238,577.00. The contract was executed November 15, with John Iafolla Construction Company, Dedham, the low bidder. The Department of Public Works is cooperating in the construction of this new state highway, paying a portion of the cost, namely, the cost of surfacing, guard rails and traffic signal ducts.

This contract is for 4.1 miles of bituminous macadam highway extending from a point just north of New Salem Center to a point near the Orange-Millington highway about 1,400 feet north of the New Salem-Orange line, being the northern portion of the new west highway from Belchertown through New Salem, previously described. The work of clearing was started November 22 and about  $1\frac{3}{4}$  miles was cleared at the end of the year. No estimates for payment were made. The contractor's force averaged twenty-eight men, the maximum being fifty on November 24.

The principal items of plant were as follows:

- 2 Gasoline shovels
- 1 Bulldozer
- 3 Stone spreaders
- 2 Road rollers

#### GEOLOGICAL DATA

Chapter 321, Acts of 1927, provides that "The Commission shall collect and publish in its reports such information as to the geology of the region in which any of the works which it is authorized to construct may be located as may be of value in connection with the geological history of the State." Such information is being prepared for publication in a subsequent report.

#### LIST OF DRAWINGS AND TABLES APPENDED HERETO

Location of Real Estate Acquired for Quabbin Reservoir.

Takings of Real Estate (and Water Rights).

Status of Contracts Completed between Nov. 30, 1932, and Nov. 30, 1933; and in Force on November 30, 1933.

Canvass of Bids: Contract 36.

For data on Contracts Completed Prior to Nov. 30, 1932, see Sixth and Seventh Annual Reports. A General Plan of the Metropolitan Water Supply and plans and profile of the Quabbin Aqueduct Tunnel have been published in previous reports.

Respectfully submitted,

FRANK E. WINSOR, *Chief Engineer.*

20 SOMERSET STREET, BOSTON, MASS.

December 15, 1933.

# FINANCIAL STATEMENT OF THE METROPOLITAN DISTRICT WATER SUPPLY COMMISSION

EXPENDITURES AND DISBURSEMENTS FOR THE FISCAL YEAR AND FROM JULY 28,  
1926, THE DATE OF THE APPOINTMENT OF THE COMMISSION

## GENERAL OVERHEAD

	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
<i>ADMINISTRATION, Commissioners' Office:</i>		
Salaries, Commissioners . . . . .	\$9,716.66	\$76,329.46
Salaries, Clerical . . . . .	11,763.24	72,709.48
General Legal Expense . . . . .	0.00	1,377.80
Furniture and Fixtures . . . . .	295.59	2,458.37
Rent and Upkeep . . . . .	2,195.52	15,912.39
Automobile Purchase . . . . .	476.00	2,464.90
Automobile Maintenance . . . . .	297.46	2,224.48
Miscellaneous Expense (undistributed) . . . . .	964.88	11,010.87
Advertising . . . . .	612.48	5,656.00
Printing and Blueprinting . . . . .	1,647.24	7,070.01
Stationery and Office Supplies . . . . .	287.78	1,599.95
Postage . . . . .	209.20	812.25
Total Administration, Commissioners' Office	\$28,466.05	\$199,625.96
<i>ENGINEERING, Headquarters' Office:</i>		
Salaries, Engineering . . . . .	\$75,439.83	\$547,131.93
Salaries, Clerical . . . . .	9,189.93	65,268.83
General Consultant Expense . . . . .	7,540.79	115,154.72
General Legal Expense . . . . .	0.00	53,160.29
Furniture and Fixtures . . . . .	1,122.71	13,238.90
Laboratory Equipment . . . . .	0.00	1,961.00
Laboratory Supplies . . . . .	0.00	2,071.94
Rental of Equipment . . . . .	0.00	3,370.02
Engineering Instruments . . . . .	25.08	1,053.04
Rent and Upkeep of Boston Office . . . . .	10,327.46	73,282.06
Rent and Upkeep of Springfield Laboratory . . . . .	0.00	3,950.54
Automobile Purchase . . . . .	476.00	3,151.60
Automobile Maintenance . . . . .	297.58	3,113.78
Special Experiments . . . . .	0.00	2,304.63
Miscellaneous Expense (undistributed) . . . . .	707.13	19,433.38
Printing and Blueprinting . . . . .	412.71	13,056.77
Stationery and Office Supplies . . . . .	682.78	4,060.20
Postage . . . . .	229.00	1,333.58
Total Engineering, Headquarters' Office .	\$106,451.00	\$926,097.21



	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
UNASSIGNED:		
Unassigned Supplies and Equipment . . . . .	\$-32.09	\$572.63
Total Unassigned . . . . .	\$-32.09	\$572.63
Total General Overhead . . . . .	\$134,884.96	\$1,126,295.80

DISTRIBUTION OF GENERAL OVERHEAD

ADMINISTRATION, <i>Commissioners' Office</i> :		
Wachusett-Coldbrook Tunnel . . . . .	\$6,903.41	\$69,679.55
Coldbrook-Swift Tunnel . . . . .	5,005.89	18,183.84
Quabbin Reservoir . . . . .	8,718.74	78,711.67
Main Dam and Dike . . . . .	7,838.01	24,360.62
Southern Sudbury Emergency Supply . . . . .	0.00	8,690.28
Total Administration, Commissioners' Office	\$28,466.05	\$199,625.96
ENGINEERING, <i>Headquarters' Office</i> :		
Wachusett-Coldbrook Tunnel . . . . .	\$25,767.48	\$283,791.72
Coldbrook-Swift Tunnel . . . . .	19,061.98	75,114.84
Quabbin Reservoir . . . . .	30,815.19	437,560.38
Main Dam and Dike . . . . .	30,806.35	96,222.30
Southern Sudbury Emergency Supply . . . . .	0.00	33,407.97
Total Engineering, Headquarters' Office . . . . .	\$106,451.00	\$926,097.21

WACHUSETT-COLDBROOK TUNNEL SECTION OF QUABBIN AQUEDUCT,  
WARE SUPPLY

GENERAL OVERHEAD:		
Administration . . . . .	\$6,903.41	\$69,679.55
Engineering . . . . .	25,767.48	283,791.72
Total General Overhead . . . . .	\$32,670.89	\$353,471.27
ENGINEERING:		
Salaries, Engineering and Clerical . . . . .	\$4,439.04	\$387,819.58
Consultant Expense . . . . .	38.20	7,612.36
Labor . . . . .	359.20	1,791.20
Furniture and Fixtures . . . . .	0.00	2,240.89
Engineering Instruments . . . . .	1.86	7,741.67
Rent and Upkeep . . . . .	2,029.57	14,756.46
Automobile Purchase . . . . .	1,294.50	11,242.97
Automobile Maintenance . . . . .	393.64	14,701.73
Contracts for Investigations and Surveys . . . . .	0.00	18,640.69
Miscellaneous Expense (undistributed) . . . . .	223.21	8,914.50
Advertising . . . . .	0.00	6.05
Printing and Blueprinting . . . . .	100.51	947.65
Stationery and Office Supplies . . . . .	174.23	2,724.08
Postage . . . . .	74.80	393.64
Total Engineering . . . . .	\$9,128.76	\$479,533.47

REAL ESTATE, <i>General Construction</i> :		
Legal and Expert Expense . . . . .	\$155.52	\$5,652.66
Consultant Expense . . . . .	0.00	455.66
Labor . . . . .	36.00	1,173.30
Miscellaneous Expense (undistributed) . . . . .	262.65	846.75
Printing and Blueprinting . . . . .	1.66	45.14

	Year ending Nov. 30, 1933	P.D. 147 Total to Nov. 30, 1933
Purchases and Settlements . . . . .	\$838.45	\$121,539.16
Taxes . . . . .	179.30	3,080.17
Maintenance of Real Estate . . . . .	58.95	622.83
Police Protection, Labor . . . . .	0.00	31.00
Fire Protection, Equipment . . . . .	0.00	30.97
Special Agents, Salaries . . . . .	2,296.00	12,949.00
Furniture and Fixtures . . . . .	0.00	117.67
Automobile Purchase . . . . .	0.00	1,222.50
Automobile Maintenance . . . . .	349.89	2,124.30
Miscellaneous Expense (undistributed) . . . . .	179.56	1,201.73
Printing and Blueprinting . . . . .	18.62	26.51
Stationery and Office Supplies . . . . .	2.05	5.48
Postage . . . . .	9.00	21.36
Total Real Estate . . . . .	\$4,387.65	\$151,146.19
WARE WATERSHED PROTECTION:		
Salaries, Engineering and Clerical . . . . .	\$21,577.39	\$67,443.44
Legal and Expert Expense . . . . .	3,520.12	13,181.24
Consultant Expense . . . . .	0.00	763.70
Labor . . . . .	556.45	8,875.24
Engineering Instruments . . . . .	126.10	126.10
Contract 27, for Swamp Improvement above Ware River Intake . . . . .	0.00	4,395.51
Contract 39, for Rutland-Holden Sewer . . . . .	50,414.17	50,414.17
Automobile Purchase . . . . .	543.95	543.95
Automobile Maintenance . . . . .	984.89	1,566.37
Miscellaneous Expense (undistributed) . . . . .	1,200.14	3,400.97
Printing and Blueprinting . . . . .	114.02	403.01
Stationery and Office Supplies . . . . .	56.35	62.35
Installed Equipment . . . . .	2,112.74	4,159.70
Purchases and Settlements . . . . .	450,076.04	1,019,178.01
Taxes . . . . .	5,191.93	17,085.30
Maintenance of Real Estate . . . . .	7.20	140.01
Total Ware Watershed Protection . . . . .	\$536,481.49	\$1,191,739.07
WARE DIVERSION DAMAGES:		
Salaries, Engineering and Clerical . . . . .	\$21,728.78	\$70,479.66
Legal and Expert Expense . . . . .	738.44	2,550.01
Consultant Expense . . . . .	19,081.39	29,886.84
Labor . . . . .	32.85	2,206.88
Furniture and Fixtures . . . . .	23.44	23.44
Laboratory Equipment . . . . .	14.29	121.15
Laboratory Supplies . . . . .	56.89	115.91
Engineering Instruments . . . . .	19.02	511.00
Rental of Equipment . . . . .	15.50	197.75
Automobile Purchase . . . . .	145.38	145.38
Automobile Maintenance . . . . .	1,060.99	2,295.76
Contracts for Investigations and Surveys . . . . .	0.00	63.27
Materials of Construction . . . . .	0.00	136.51
Miscellaneous Expense (undistributed) . . . . .	1,653.00	7,029.20
Printing and Blueprinting . . . . .	271.27	527.47
Stationery and Office Supplies . . . . .	18.91	18.91
Postage . . . . .	.87	6.62
Purchases and Settlements . . . . .	75,525.00	123,475.00
Total Ware Diversion Damages . . . . .	\$120,386.02	\$239,790.76



Year ending  
Nov. 30,  
1933

Total to  
Nov. 30,  
1933

# PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS:

Completed Contracts Nos. 4, 8, 10, 12, 14, 17,  
18, 19, 22, 24, 25, 26, 28, 29, 31 . . .

\$0.00 \$9,629,739.99

# PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:

Installed Equipment . . . . .	\$-1,312.00	\$58,992.23
Temporary Equipment . . . . .	1,410.00	6,423.60
Labor . . . . .	947.97	3,086.32
Contracts for Equipment for Surveys . . . . .	0.00	898.34
Maintenance of Partially Completed Structures . . . . .	1,279.50	6,289.49
Maintenance of Grounds . . . . .	223.85	2,255.36
Purchase of Plants, Trees and Shrubbery . . . . .	216.19	830.82
Rental of Equipment . . . . .	0.00	7.00
Miscellaneous Expense . . . . .	17.63	9,453.84

Total . . . . .	\$2,783.14	\$88,237.00
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Total Wachusett-Coldbrook Tunnel, Ware  
Supply . . . . .

\$705,837.95 \$12,133,657.75

# SPECIAL INVESTIGATION — POLLUTION OF WARE AND QUINAPOXET WATERSHEDS (Expenditures under Chapter 66, Resolves of 1931)

Salaries, Engineering . . . . .	\$0.00	\$986.67
Miscellaneous Expense . . . . .	0.00	1,009.32

Total Special Investigation . . . . .	\$0.00	\$1,995.99
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# COLDBROOK-SWIFT TUNNEL SECTION OF QUABBIN AQUEDUCT

## GENERAL OVERHEAD:

Administration . . . . .	\$5,005.89	\$18,183.84
Engineering . . . . .	19,061.98	75,114.84

Total General Overhead . . . . .	\$24,067.87	\$93,298.68
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## ENGINEERING:

Salaries, Engineering and Clerical . . . . .	\$52,862.87	\$159,444.07
Consultant Expense . . . . .	255.90	255.90
Labor . . . . .	251.80	536.25
Furniture and Fixtures . . . . .	97.27	762.58
Engineering Instruments . . . . .	195.52	4,406.97
Rent and Upkeep . . . . .	1,239.16	7,798.98
Automobile Purchase . . . . .	0.00	7,427.97
Automobile Maintenance . . . . .	1,890.05	13,741.91
Contracts for Investigations and Surveys . . . . .	0.00	13,525.66
Materials of Construction . . . . .	0.00	2.25
Miscellaneous Expense (undistributed) . . . . .	1,009.11	6,812.81
Printing and Blueprinting . . . . .	153.84	639.87
Stationery and Office Supplies . . . . .	210.68	1,806.05
Postage . . . . .	86.37	355.66

Total Engineering . . . . .	\$58,252.57	\$217,516.93
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## REAL ESTATE:

Legal and Expert Expense . . . . .	\$149.85	\$3,040.32
Labor . . . . .	0.00	12.20
Miscellaneous Expense (undistributed) . . . . .	0.00	27.16
Printing and Blueprinting . . . . .	0.00	34.87
Postage . . . . .	0.00	5 68

	Year ending Nov. 30, 1933	P.D. 147 Total to Nov. 30, 1933
Purchases and Settlements . . . . .	\$4,300.00	\$22,325.00
Taxes . . . . .	167.86	296.51
Maintenance of Real Estate . . . . .	15.60	24.85
Fire Protection, Equipment . . . . .	0.00	60.86
Total Real Estate . . . . .	\$4,633.31	\$25,827.45
PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS:		
Contract No. 20, Construction of Coldbrook-Swift Tunnel . . . . .	\$1,397,020.68	\$3,637,492.50
Total Contracts . . . . .	\$1,397,020.68	\$3,637,492.50
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Labor . . . . .	\$0.00	\$64.75
Installed Equipment . . . . .	0.00	91.87
Miscellaneous Expense . . . . .	1,040.85	1,274.29
Total . . . . .	\$1,040.85	\$1,430.91
Total Coldbrook-Swift Tunnel . . . . .	\$1,485,015.28	\$3,975,566.47
QUABBIN RESERVOIR EXCEPT MAIN DAM AND DIKE		
GENERAL OVERHEAD:		
Administration . . . . .	\$8,718.74	\$78,711.67
Engineering . . . . .	30,815.19	437,560.38
Total General Overhead . . . . .	\$39,533.93	\$516,272.05
ENGINEERING:		
Salaries, Engineering and Clerical . . . . .	\$10,752.02	\$282,468.11
Labor . . . . .	1,075.20	5,535.99
Furniture and Fixtures . . . . .	16.41	2,957.38
Laboratory Equipment . . . . .	218.46	477.40
Laboratory Supplies . . . . .	615.34	921.48
Rental of Equipment . . . . .	0.00	16.75
Engineering Instruments . . . . .	107.66	6,274.90
Rent and Upkeep . . . . .	1,233.91	5,289.55
Automobile Purchase . . . . .	4,190.29	16,836.39
Automobile Maintenance . . . . .	719.33	11,792.53
Special Experiments . . . . .	30.40	422.80
Contracts for Investigations and Surveys . . . . .	0.00	10,594.79
Office Buildings . . . . .	79.63	4,915.54
Miscellaneous Expense (undistributed) . . . . .	396.19	4,132.66
Printing and Blueprinting . . . . .	332.17	1,550.38
Stationery and Office Supplies . . . . .	523.10	4,451.21
Postage . . . . .	185.25	699.64
Total Engineering . . . . .	\$20,475.36	\$359,337.50
REAL ESTATE:		
Legal and Expert Expense . . . . .	\$14,368.48	\$132,800.30
Labor . . . . .	24.00	95.35
Furniture and Fixtures . . . . .	0.00	15.68
Miscellaneous Expense (undistributed) . . . . .	962.37	4,861.85
Advertising . . . . .	0.00	208.66
Printing and Blueprinting . . . . .	397.15	1,103.37
Stationery and Office Supplies . . . . .	0.00	0.45
Purchases and Settlements . . . . .	388,051.52	5,470,303.50



	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
Taxes . . . . .	\$60,851.19	\$185,754.36
Maintenance of Real Estate . . . . .	1,599.82	3,155.35
Water Supply System . . . . .	0.00	16.00
Fire Protection, Equipment . . . . .	31.36	3,467.22
Automobile Purchase . . . . .	0.00	771.69
Automobile Maintenance . . . . .	19.29	242.14
Labor . . . . .	21.20	27.20
Miscellaneous Expense . . . . .	14.88	107.30
Police Protection, Labor . . . . .	4.00	14.00
Special Agents, Salaries . . . . .	2,296.00	13,297.33
Equipment . . . . .	0.00	118.33
Automobile Purchase . . . . .	0.00	1,236.96
Automobile Maintenance . . . . .	337.45	2,354.51
Miscellaneous Expense (undistributed) . . . . .	144.29	943.38
Printing and Blueprinting . . . . .	0.00	41.60
Stationery and Office Supplies . . . . .	1.01	9.33
Postage . . . . .	.90	11.22
Renting Agents, Salaries . . . . .	2,632.00	15,467.43
Furniture and Fixtures . . . . .	0.00	29.29
Miscellaneous Expense (undistributed) . . . . .	37.69	423.71
Printing and Blueprinting . . . . .	18.62	18.62
Stationery and Office Supplies . . . . .	10.00	26.08
Postage . . . . .	63.23	85.52
Payments to Towns . . . . .	4,500.00	10,500.00
 Total Real Estate . . . . .	 \$476,386.45	 \$5,847,507.73

## QUABBIN RESERVOIR DAMAGES:

Salaries, Engineering . . . . .	\$0.00	\$48.68
Legal and Expert Expense . . . . .	49.02	980.02
Board of Referees . . . . .	9.75	9.75
Consultant Expense . . . . .	715.45	2,158.82
Miscellaneous Expense . . . . .	5.90	18.15
Purchases and Settlements . . . . .	1,425.00	45,285.00
 Total Quabbin Reservoir Damages . . . . .	 \$2,205.12	 \$48,500.42

## SWIFT DIVERSION DAMAGES:

Salaries, Engineering and Clerical . . . . .	\$11,833.22	\$55,352.83
Legal and Expert Expense . . . . .	970.50	4,278.62
Consultant Expense . . . . .	22,495.02	49,597.77
Labor . . . . .	0.00	73.70
Furniture and Fixtures . . . . .	30.96	30.96
Laboratory Equipment . . . . .	128.58	705.93
Laboratory Supplies . . . . .	508.87	809.37
Engineering Instruments . . . . .	171.17	732.20
Rental of Equipment . . . . .	1.50	10.50
Automobile Purchase . . . . .	1,308.41	1,308.41
Automobile Maintenance . . . . .	1,106.47	1,413.26
Contracts for Investigations and Surveys . . . . .	0.00	569.47
Materials of Construction . . . . .	0.00	18.99
Miscellaneous Expense (undistributed) . . . . .	394.34	5,378.92
Printing and Blueprinting . . . . .	197.43	583.33
Stationery and Office Supplies . . . . .	20.75	20.75
Purchases and Settlements . . . . .	364,725.00	567,225.00
 Total Swift Diversion Damages . . . . .	 \$403,892.22	 \$688,110.01

## QUABBIN RESERVOIR — CEMETERIES

## QUABBIN PARK CEMETERY CONSTRUCTION:

	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
Salaries, Engineering and Clerical . . . . .	\$340.99	\$10,705.43
Legal and Expert Expense . . . . .	0.00	65.00
Consultant Expense . . . . .	0.00	125.00
(Construction) Labor . . . . .	1,219.38	8,600.91
Tools and Equipment . . . . .	1.63	83.96
Automobile Purchase . . . . .	0.00	1,615.37
Automobile Maintenance . . . . .	449.19	982.61
Rental of Equipment . . . . .	0.00	33.19
Purchases and Settlements . . . . .	4,000.00	8,850.00
Construction Materials . . . . .	142.90	1,465.53
Purchase and Planting of Trees and Shrubbery . . . . .	63.33	218.93
Receiving Vault . . . . .	0.00	2,768.85
Water Supply System . . . . .	2.00	1,251.97
Maintenance of Grounds . . . . .	761.53	1,831.23
Miscellaneous Expense (undistributed) . . . . .	15.97	155.01
Printing and Blueprinting . . . . .	7.17	157.58
Stationery and Office Supplies . . . . .	5.52	9.03
Contract 34, Construction of Driveways . . . . .	0.00	7,842.94
Sub Total Quabbin Park Cemetery Construction . . . . .	\$7,009.61	\$46,762.54

## REMOVALS FROM CEMETERIES WITHIN RESERVOIR AREA TO QUABBIN PARK CEMETERY:

Salaries, Engineering and Clerical . . . . .	\$2,669.79	\$2,839.34
Tools and Equipment . . . . .	147.88	412.14
Automobile Purchase . . . . .	0.00	2,669.99
Automobile Maintenance . . . . .	382.60	384.05
Removal and Reinterment of Bodies . . . . .	3,774.59	4,313.28
Removal and Resetting of Monuments . . . . .	2,786.46	2,950.86
Miscellaneous Expense . . . . .	0.00	2.00
Rental of Equipment . . . . .	10.50	10.50
Sub Total Removals to Quabbin Park Cemetery . . . . .	\$9,771.82	\$13,582.16

## REMOVALS FROM CEMETERIES WITHIN RESERVOIR AREA TO CEMETERIES OTHER THAN QUABBIN PARK:

Salaries, Engineering and Clerical . . . . .	\$750.80	\$5,646.16
Automobile Purchase . . . . .	0.00	380.00
Automobile Maintenance . . . . .	47.29	62.09
Purchases and Settlements . . . . .	985.50	6,645.10
Perpetual Care Fund Contributions . . . . .	0.00	100.00
Removal and Reinterment of Bodies . . . . .	652.80	5,887.75
Removal and Resetting of Monuments . . . . .	760.83	5,420.02
Miscellaneous Expense . . . . .	0.00	117.91
Sub Total Removals to Other Cemeteries . . . . .	\$3,197.22	\$24,259.03
Total Quabbin Reservoir Cemeteries . . . . .	\$19,978.65	\$84,603.73

## PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:

Installed Equipment . . . . .	\$0.00	\$214.78
Total . . . . .	\$0.00	\$214.78



	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
<b>HIGHWAY AND PUBLIC UTILITY RELOCATION:</b>		
Salaries, Engineering and Clerical . . . . .	\$47,093.84	\$95,564.43
Legal and Expert Expense . . . . .	0.00	49.10
Consultant Expense . . . . .	8,449.40	8,449.40
Labor . . . . .	1,640.31	1,882.01
Furniture and Fixtures . . . . .	61.74	61.74
Contract No. 21, Construction of about 5.2 miles of the Ware-Belchertown Highway . . . . .	5,000.00	129,980.25
Contract No. 40, Removal and Relocation of Transmission and Telephone Lines and Substation of the New England Power Co. and Central Massachusetts Electric Co. . . . .	68,046.10	68,046.10
Contract 41, Construction of about 9.1 miles of the Belchertown-Pelham Highway in Belchertown and Pelham . . . . .	53,661.48	53,661.48
Contract 43, Construction of about 7.6 miles of Extension of Belchertown-Pelham Highway in Shutesbury and New Salem to New Salem Center . . . . .	55,295.48	55,295.48
Installed Equipment . . . . .	319.63	417.45
Temporary Equipment . . . . .	0.00	149.50
Engineering Instruments . . . . .	266.91	433.68
Automobile Purchase . . . . .	0.00	535.00
Automobile Maintenance . . . . .	1,422.21	2,472.68
Miscellaneous Expense (undistributed) . . . . .	866.46	1,443.12
Printing and Blueprinting . . . . .	182.83	202.22
Stationery and Office Supplies . . . . .	23.83	83.40
<b>Total Highway and Public Utility Relocation . . . . .</b>	<b>\$242,330.22</b>	<b>\$418,727.04</b>
<b>Total Quabbin Reservoir, Except Main Dam and Dike . . . . .</b>	<b>\$1,204,801.95</b>	<b>\$7,963,273.26</b>
<b>QUABBIN RESERVOIR MAIN DAM AND DIKE</b>		
<b>GENERAL OVERHEAD:</b>		
Administration . . . . .	\$7,838.01	\$24,360.62
Engineering . . . . .	\$30,806.35	96,222.30
<b>Total General Overhead . . . . .</b>	<b>\$38,644.36</b>	<b>\$120,582.92</b>
<b>ENGINEERING:</b>		
Salaries, Engineering and Clerical . . . . .	\$41,623.00	\$105,613.38
Consultant Expense . . . . .	724.30	8,295.52
Labor . . . . .	4,132.60	5,140.00
Furniture and Fixtures . . . . .	127.22	191.40
Laboratory Equipment . . . . .	0.00	759.77
Rental of Equipment . . . . .	911.00	1,341.50
Engineering Instruments . . . . .	3.27	149.09
Rent and Upkeep . . . . .	28.90	44.90
Automobile Maintenance . . . . .	875.28	1,435.91
Contracts for Investigations and Surveys . . . . .	10,817.92	60,802.38
Special Experiments . . . . .	1,313.42	1,313.42
Water Supply System . . . . .	10.00	10.00
Miscellaneous Expense (undistributed) . . . . .	6,662.91	8,563.86
Printing and Blueprinting . . . . .	129.19	505.81
Stationery and Office Supplies . . . . .	54.12	199.17
<b>Total Engineering . . . . .</b>	<b>\$67,413.13</b>	<b>\$194,366.11</b>

	Year ending Nov. 30, 1933	Total to Nov. 30, 1933
PERMANENT CONSTRUCTION-CONSTRUCTION CONTRACTS:		
Contract No. 30, Constructing Stream Control Works at Main Dam . . . . .	\$120,274.87	\$544,610.60
Contract No. 32, Constructing Exploratory Caissons at Main Dam and Dike . . . . .	0.00	162,838.33
Contract No. 36, Constructing a Core Wall to Sound Rock at the Site of the Dike . . . . .	606,433.45	606,433.45
Total Contracts . . . . .	\$726,708.32	\$1,313,882.38
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS:		
Labor . . . . .	\$0.00	\$2,519.40
Installed Equipment . . . . .	0.00	3,253.00
Temporary Equipment . . . . .	0.00	1,549.81
Miscellaneous Expense . . . . .	1,164.65	2,260.66
Total . . . . .	\$1,164.65	\$9,582.87
Total Quabbin Reservoir Main Dam and Dike . . . . .	\$833,930.46	\$1,638,414.28
SOUTHERN SUDBURY EMERGENCY SUPPLY		
GENERAL OVERHEAD: . . . . .	\$0.00	\$42,098.25
ENGINEERING: . . . . .	0.00	44,235.07
REAL ESTATE:		
Legal and Expert Expense . . . . .	29.61	2,251.21
Consultant Expense . . . . .	0.00	116.87
Printing and Blueprinting . . . . .	0.00	4.28
Purchases and Settlements . . . . .	25.00	27,788.22
Taxes . . . . .	0.00	392.60
Total Real Estate . . . . .	\$54.61	\$30,553.18
SOUTHERN SUDBURY DIVERSION DAMAGES . . . . .	\$0.00	\$50,752.66
PERMANENT CONSTRUCTION — CONSTRUCTION CONTRACTS		
Completed Contracts Nos. 6, 7, 11, 13, 15, 16 . . . . .	0.00	375,194.44
Contract No. 5, Cordaville Pipe Line . . . . .	0.00	83,262.86
PERMANENT CONSTRUCTION — EXCEPT CONSTRUCTION CONTRACTS . . . . .	0.00	11,937.37
Total Southern Sudbury Emergency Supply . . . . .	\$54.61	\$638,033.83
SUMMARY		
Wachusett-Coldbrook Tunnel, Ware Supply . . . . .	\$705,837.95	\$12,133,657.75
Special Investigation — Pollution of Ware and Quinapoxet Watersheds . . . . .	0.00	1,995.99
Coldbrook-Swift Tunnel . . . . .	1,485,015.28	3,975,566.47
Quabbin Reservoir Except Main Dam and Dike . . . . .	1,204,801.95	7,963,273.26
Quabbin Reservoir Main Dam and Dike . . . . .	833,930.46	1,638,414.28
Southern Sudbury Emergency Supply . . . . .	54.61	638,033.83
Unassigned . . . . .	-32.09	572.63
Grand Total . . . . .	\$4,229,608.16	\$26,351,514.21
RECEIPTS FROM RENTS, SALES, ETC.		
Sales . . . . .	\$7,448.82	\$115,773.31
Rents . . . . .	49,584.55	253,991.75
Miscellaneous . . . . .	251.65	3,171.64
Total Receipts . . . . .	\$57,285.02	\$372,936.70



COMMONWEALTH OF MASSACHUSETTS  
METR. DISTR. WATER SUPPLY COMMISSION  
**LOCATION OF REAL ESTATE ACQUIRED FOR THE  
QUABBIN RESERVOIR**  
(TITLE VESTED IN COMMONWEALTH)

TOWNS	TOTAL - NOV. 30, 1932.		TOTAL FOR YEAR ENDING NOV. 30, 1933 (ACRES)	TOTAL NOV. 30, 1933 (ACRES)	REMARKS
	1932 ANNUAL REPORT (ACRES)	REVISED-SEE NOTE (ACRES) *			
BELCHERTOWN	1,663	1,663	946	2,609	* Revisions have been made using acreages obtained from surveys wherever available, otherwise from deeds, property blanks etc.
DANA	7,487	7,480	406	7,886	
ENFIELD	7,057	7,057	638	7,695	
GREENWICH	9,535	9,535	388	9,923	
HARDWICK	2,233	2,233	311	2,544	
NEW SALEM	6,318	6,318	347	6,665	* * 75 acres were transferred to the Massachusetts Department of Conservation.
DELHAM	2,691	2,691	1,518	4,209	
PETERSHAM	761	686 **	—	686	
PRESCOTT	8,983	8,991	756	9,747	
SHUTESBURY	1,518	1,521	141	1,662	
WARE	460	464	181	645	
WENDELL	36	36	—	36	
TOTALS	48,742	48,675	5,632	54,307	

ATTENTION: TO THE DIRECTOR  
 DEPARTMENT OF THE ARMY  
 WASHINGTON, D.C. 20315

RECOMMENDATION FOR AWARD OF  
 THE DISTRICT OF COLUMBIA

NAME OF AWARD: DISTRICT OF COLUMBIA

RECOMMENDATION FOR AWARD OF THE DISTRICT OF COLUMBIA  
 TO THE DISTRICT OF COLUMBIA

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 TO THE DISTRICT OF COLUMBIA



COMMONWEALTH OF MASSACHUSETTS  
METR. DISTR. WATER SUPPLY COMMISSION  
**TAKINGS OF REAL ESTATE (AND WATER RIGHTS)**

TAKING FOR	TAK- ING NO.	TOWN	COUNTY	DATE OF TAKING	PLAN NO.	TITLE VESTED IN COMMONWEALTH FEE (Acres)	EASEMENT (Acres)
Southern Sudbury Emergency Supply	1 to 9 incl.	Details previously 1930 Annual Report.		See	C-1 to C-15 incl.	258.81 (Also Water Rights)	29.02
Wachusett-Coldbrook Tunnel section of Quabbin Aqueduct.	1 to 4 incl.	Details previously 1930 Annual Report.		See	T-1 to T-13 incl.	570.22	
Coldbrook-Swift Tunnel section of Quabbin Aqueduct.	1 to 3 incl.	Details previously 1931 Annual Report. *(391.42 acres of this total are within the Quabbin Res. Area)		See	T-14 to T-27 incl.	* 544.81	4.06
Quabbin Reservoir (Swift River Reservoir)	1 to 5 incl.	Details previously 1931 and 1932 Annual Reports.		See	S-1 to S-9 incl.	431.90	0.39
" " Belchertown-Pelham Hwy.	6	Belchertown Pelham	Hampshire	July 11, 1933	S-10 to S-14 incl.	25.79 38.46	0.28 0.11
" " " " Extension	10	Shutesbury New Salem	Franklin	Aug. 11, 1933	S-18 to S-23 incl.	31.55 41.58	1.46 2.07
" " " " "	12	New Salem Orange	Franklin	Nov. 14, 1933	S-25 to S-27 incl.	34.21 1.92	2.94
" " Transmission Line Relocation.	7	Enfield	Hampshire	July 11, 1933	S-16		5.03
" " " " "	8	"	"	July 25, 1933	S-15		4.28
" " " " "	9	Ware	"	July 25, 1933	S-17		.55
" " " " "	11	"	"	Aug. 11, 1933	S-24		2.74
						605.41	19.85
Ware River Watershed. - Real Estate	1	{Details previously 1932 Annual Report.		See }	W-1	0.25	Rights
" " " - Diversion of Flood Waters					No Plan	Water	
" " " - Rutland Holden Sewer	2	Holden Rutland	Worcester	July 11, 1933	A-1 to A-14 incl.		18.55 4.39
						0.23	22.94

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COMMONWEALTH OF MASSACHUSETTS  
METR. DIST. WATER SUPPLY COMMISSION

# STATUS OF CONTRACTS COMPLETED BETWEEN NOV. 30, 1932 AND NOV. 30, 1933

CONT. NO.	DESCRIPTION	LOCATION	SUPPLY	CONTRACTOR	BIDS OPENED	NO. OF BIDS	CONTRACT AWARDED	BASIS OF AWARD	FINAL ESTIMATE	DATE OF FINAL EST.
30	Stream Control Works at Main Dam - Quabbin Reservoir	Belchertown, Enfield and Ware	Swift	Northern States Contracting Co.	July 17, 1931	19	July 21, 1931	\$560,922.50	\$544,610.60	Aug. 29, 1933
37	Purchase of Power at Dike Site	Enfield	Swift	New England Power Co.	Date of Agreement = Sept. 21, 1932		Agreed Rates	Agreed Rates	3,348.00	Feb. 1, 1933

## STATUS OF CONTRACTS IN FORCE ON NOV. 30, 1933

CONT. NO.	DESCRIPTION	LOCATION	SUPPLY	CONTRACTOR	BIDS OPENED	NO. OF BIDS	CONTRACT AWARDED	BASIS OF AWARD	PAYMENTS TO DATE
20	Coldbrook-Swift Tunnel.	Barre, Hardwick and Greenwick	Swift	Wenzel & Henoch, Construction Co.	Mar. 27, 1931	13	April 10, 1931	\$4,978,031.80	\$3,637,492.50
23	Making Borings.	Belchertown, Ware, Enfield, Greenwick & Hardwick	Swift	Sprague & Henwood Inc.	Nov. 5, 1929	6	Nov. 5, 1929	10,950.00	38,513.84
33	Purchase of Power at Shaft 1.	West Boylston	Ware	New England Power Co.	Date of Agreement = Aug. 6, 1931		Agreed Rates	Agreed Rates	1,611.63
35	Purchase of Power at Dam Site.	Enfield	Swift	New England Power Co.	Date of Agreement = June 2, 1932		Agreed Rates	Agreed Rates	2,659.10
36	Core Wall to Sound Bed Rock at Dike Site.	Enfield & Ware	Swift	West Construction Co.	Dec. 9, 1932	25	Dec. 28, 1932	999,265.00	606,433.45
39	Construction of Trunk Sewer.	Rutland & Holden	Ware	James J. Coughlan & Sons, Inc.	July 7, 1933	21	July 11, 1933	184,327.50	50,414.17
40	Removal and Relocation of Transmission and Telephone Lines & Sub-Station.	New Salem, Belchertown, Enfield & Ware	Swift	New England Power Company & Central Massachusetts Electric Company	Date of Agreement = June 20, 1933		Actual Cost	Actual Cost	68,046.10
41	Construction of Portion of Belchertown - Pelham Highway.	Belchertown & Pelham	Swift	Carlo Bianchi Co., Inc.	July 18, 1933	14	July 19, 1933	222,335.50	* 83,975.88
42	Use of Worcester Sewerage System and Treatment Works % Rutland-Holden Sewer.	Worcester	Ware	City of Worcester	Date of Agreement = May 1, 1933		Lump Sum = Annual Charge =	325,000.00	325,000.00
43	Construction of Extension of Belchertown Pelham Highway to New Salem Center.	Shutesbury & New Salem	Swift	V. Barletta Co.	Aug. 11, 1933	7	Aug. 22, 1933	300,397.50	55,295.48
44	Construction of Extension of Belchertown Pelham Highway North of New Salem Center.	New Salem & Orange	Swift	John lafolla Construction Co.	Nov. 10, 1933	9	Nov. 14, 1933	179,480.50	None

\* Proportion of Annual Maintenance Cost.

\* \* Of this amount the State Dept. of Public Works paid \$30,314.40 for surfacing, guard rail and traffic signal duct items.

Awarded to lowest bidder in each case except Contract 43, awarded to 2nd lowest bidder.





# COMMONWEALTH OF MASSACHUSETTS METE. DIST. WATER SUPPLY COMMISSION CONTRACT 36 FOR CONSTRUCTING A CREEK WALL TO SOUND DUCK AT THE SITE OF THE SITE OF THE DIST. WATER SUPPLY COMMISSION

36 OPENED DEC. 9, 1932

COMMONWEALTH OF MASSACHUSETTS METE. DIST. WATER SUPPLY COMMISSION CONTRACT 36 FOR THE CONSTRUCTION OF THE METE. DIST. WATER SUPPLY SYSTEM IN THE TOWN OF QUINCY, MASSACHUSETTS				① NEW CONSTRUCTION 80 STATE ST. BOSTON 5				② C.R. CONSTRUCTION CO. 75 BEACON ST. ROSLINDALE 5				③ J.F. FERRARIO 380 FRANKLIN ST. BOSTON 5				④ BACON CONSTRUCTION COMPANY 551 FRANKLIN ST. NEW YORK				⑤ JAMES J. CONNELLEY & SONS 50 FRANKLIN ST. NEW YORK				⑥ CENEDELLA & CO. 187 MAIN ST. MILWAUKEE				⑦ WILLIS H. MOORE & SONS GREENWICH, CONN.				⑧ ROOSE & FLEMING COMPANY 1942 WEST 42ND ST. NEW YORK				⑨ NEWHART & STANLEY CONTRACTORS CO. 110 LIBERTY ST. NEW YORK				⑩ THE FOUNDATION COMPANY 170 LEXINGTON ST. NEW YORK			
ITEM	DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT	PRICE	AMOUNT								
1	Earth excavation in open cut to E-400	Cu Yd	21,500	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510	1.14	24,510								
2	Earth excavation in open cut to E-400	Cu Yd	70,000	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800	1.14	79,800								
3	Back excavation as shown in open cut	Cu Yd	9,500	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830	1.14	10,830								
4	Back excavation as shown in open cut	Cu Yd	5,000	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700	1.14	5,700								
5	Stripping	Sq Yd	61,000	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540	1.14	69,540								
6	Unconsolidated embankment	Cu Yd	20,000	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800								
7	Consolidated embankment	Cu Yd	20,000	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800	1.14	22,800								
8	Gravel mass concrete embankment	Cu Yd	10,000	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400								
9	Gravel mass concrete embankment	Cu Yd	10,000	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400								
10	Gravel mass concrete embankment	Cu Yd	10,000	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400	1.14	11,400								
11	Armoring (incl. fixed piles)	Sq Yd	25,000	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500	1.14	28,500								
12	Observation pipe wells	Cu Yd	1,000	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530	2.53	2,530								
13	For 4th class case and 1st class case to E-400	Cu Yd	5,000	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050	5.61	28,050								
14	Back excavation in excavations to E-400	Cu Yd	2,000	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280	1.14	2,280								
15	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
16	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
17	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
18	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
19	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
20	Back excavation in excavations to E-400	Cu Yd	200	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228	1.14	228								
21	Concrete, self placed under air pressure	Cu Yd	4,820	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391	3.61	17,391								
22	Concrete, self placed under air pressure	Cu Yd	7,500	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135	3.61	27,135								
23	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
24	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
25	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
26	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
27	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
28	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
29	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610	3.61	3,610								
30	Concrete, self placed under air pressure	Cu Yd	1,000	3.61	3,610	3.61	3,610	3.61	3,6																																		

